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Cover picture shows one of the lime kilns at the ammonia-soda plant of the Mathieson Alkali Works located at Lake Charles, La. From similar kilns at the Saltville, Va., plant comes the raw material for production of carbon dioxide. [*This cover released for editorial use by The Pfaudler Co.*]

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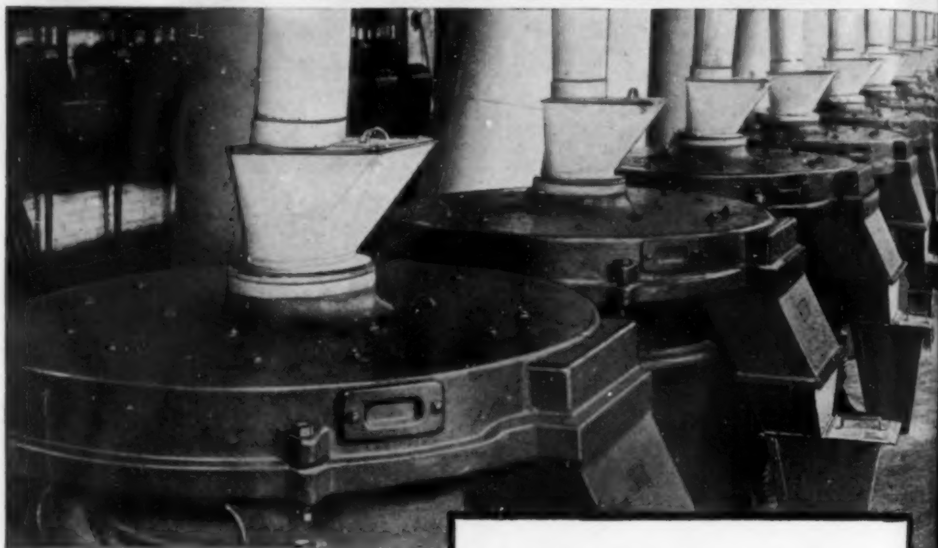

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S. D. KIRKPATRICK, *Editor*

Dollars and Sense

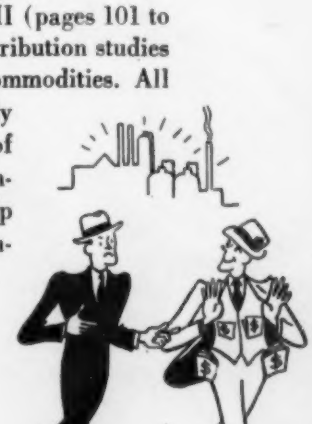
COLONEL LEONARD P. AYRES, the Cleveland banker, is a keen observer of human nature as well as of economic progress. He once told us a story of two young statisticians that seems to find a parallel among certain chemists and engineers of our acquaintance. These two friends of Colonel Ayres had come from parents of moderate circumstances and had graduated from the same college with about the same marks. Both had been employed by the same company for about ten years and had gained about an equal knowledge of the purely statistical phases of its business. Yet one was getting a salary more than twice that of the other. Why this difference?

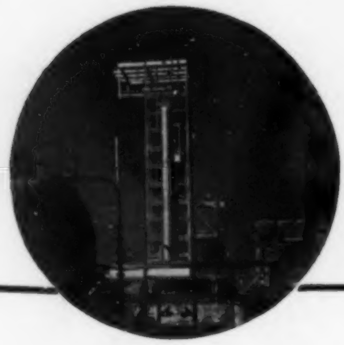
Perhaps part of the answer is concealed in the human equation; but Colonel Ayres also found certain other reasons that were immediately apparent. One of the men had applied himself solely to the technique of his job as a statistician. The other had used his technical training as a stepping-stone toward a better understanding of the business as a whole. He had acquired an economic insight into the company's problems that immediately made him more valuable to his employer—and to himself. It was this plus-value that had been rewarded—that had distinguished him from his fellow statistician and the others in that department.

Dr. Henry G. Knight, chief of the U. S. Bureau of Chemistry and Soils, has recently brought this lesson a step nearer home, with these words: "If a chemist in addition to being a specialist also becomes somewhat of a generalist, his outlook to the future is not through a keyhole, but rather from the roof. Broad fields are open to him. He can go back to the home-nest in the laboratory, but the roof-top view goes with him. If he has certain qualities, he may find now before him opportunity for administrative work. Industry and research and business feel a growing need for such men. They are plastic pegs that can fit themselves into many kinds of holes."

All of us have observed that the technical man who advances first to a position of greater responsibility is the man who can be counted on to get the result desired—whether it be a new product, a lower cost, or a more profitable market. After he gets the result, he usually has to sell it to some one higher up. If he is wise, he thinks and expresses himself and his proposition in dollars and cents. The amount of sales resistance encountered usually varies inversely with the amount of monetary savings involved. Dollars-and-sense is the combination that wins most often!

These annual review numbers of *Chem & Met.*, of which this is the sixteenth, have always laid their chief emphasis on the economic aspects of chemical industry. Once a year is not too often to survey raw material requirements in light of changing trends in production and consumption, such as are noted in articles by Bowles, Paine and Smith elsewhere in this issue. The overall feasibility of many industrial processes depends on careful economic balancing of many factors, as is shown only too well in Penning's article on pages 76 to 79 of this issue. Concentrated in Section II (pages 101 to 132) are the latest statistics and distribution studies for a wide variety of chemical commodities. All these facts and figures, if properly projected into the background of many current problems of the chemical process industries, should help to make more $-minded chemical engineers with better business sense.





From an

WHITHER PLASTICS?

TEN YEARS AGO producers of plastics were scattered and isolated. Except in rare cases, companies made only a single composition. But gradually other plastics were added, by development, license or purchase, until today there is a well-developed trend toward a few large organizations offering a complete line of these cellulose and synthetic resin materials. Bakelite Corporation is probably the best exemplar of this trend.

Simultaneously, another trend has been developing. The chemical manufacturers themselves, who were at one time interested merely in supplying raw materials to the plastic producers, recognized the advantages to be gained from going a step further and are now processing these materials into plastic compositions. For instance, Reilly Tar & Chemical began converting its phenol into synthetic resins. Monsanto first acquired the Dayton Petroleum Chemical Corporation, makers of resins from petroleum, and then the Fiberloid Corporation with its cellulose acetate and nitrate, cast phenolic, vinyl acetate and other plastics. Du Pont went into the production of cellulose acetate and nitrate, vinyl acetate, alkyd, urea and methyl methacrylate plastics. Carbide & Carbon, Dow, Cyanamid, Röhm and Haas and other chemical manufacturers likewise became important producers of these materials. Moving in the opposite direction, General Plastics now produces its own phenol by a new synthetic process.

Just how far these movements will go, it is too early to forecast, but it is becoming more and more obvious that the line of demaration between plastics production and chemical manufacturing is gradually disappearing. Plastics becomes more than ever a chemical industry.

CONGRESSIONAL RIGHTS DEFINED

TWO DECISIONS of the Supreme Court clearly define the constitutional rights of Congress. And this definition of the rights of the legislative body clearly emphasizes the responsibility which the legislators must assume.

On January 30 the Supreme Court ruled that Congress could establish T.V.A. with the authority to compete with private utilities. On the same day the Supreme Court announced its decision regarding National Labor Relations Board's authority to release "confidential" data. In both cases the Court admitted that competing with utilities and releasing of data would be harmful to the companies that sought relief. But the Court said that Congress had granted the authority within its constitutional rights and if Congress wanted these detrimental results to follow, the courts should not interfere.

There is nothing to make one believe that the Supreme Court likes a Congress careless of the well-being of individuals or of companies or of industries. There is every reason to believe that the courts dislike such ruthless legislation as might eventuate under this broadly interpreted authority. It is even more probable that the American people generally would dislike such a Congress and would eliminate from its membership those legislators who ruthlessly exercise such a right.

Most important of all, it now appears to be the duty of American citizens to make Congress appreciate that considerate, intelligent, conservative application of its great authority is very badly needed at this time. The rights of the public generally may be superior to the rights of any individual or any one company. But a Congress that carelessly damages the rights of individuals or of companies will soon find itself voted out of office. A sense of responsibility for conservatism should go along with the enlarged privilege of legislation which the Supreme Court now seems to grant to Congress.

REAL PHOSPHATE PROGRESS

A YEAR AGO the phosphate industry was under fire, and it rightly had the jitters. Now that it reads the report of the Congressional committee which investigated the adequacy and use of phosphate resources, it may well feel some measure of satisfaction at its vindication and at the encouragement which the report gives.

Under the chairmanship of ex-Senator Pope, a thoughtful study, with hearings in Idaho, Tennessee, and Florida, dug under the surface of misunderstandings and got down to factual bedrock. The industry and other interested chemical engineers may not agree with all the recommendations presented, notably one of them; but there is satisfaction in the fact that the inquiry has produced better understanding of the tremendous reserves

Editorial Viewpoint

of phosphate rock in the United States and of the remoteness of any shortage which might result from profitable exports.

The Phosphate Rock Institute has done an excellent job in bringing out the facts, facts which it first learned adequately through its own recent studies. The Institute and the others who assisted in the education of the Congressional committee have mitigated a threat of governmental interference with an industry that may need factual guidance, but certainly should not be meddled with by reformer officialdom.

Perhaps the only serious point of contention in the committee report is the recommendation that aggressive development by the Government of the Western phosphate lands is needed. We hope that the embryonic efforts toward economy which are being nurtured in Washington will be enough to prevent any wasteful expenditure in that direction. Research and education are indeed desirable, but government exploitation and competition is another matter.

SYNTHETICS FOR PREPAREDNESS

A NEW LIST of strategic materials has been announced by the Army and Navy Munitions Board. These commodities are those essential for national defense which must be imported in whole or in part, from sources outside the continental United States. There are 17 commodities so recognized by this 1939 list, and American chemical enterprise is very much interested in the entire list.

There is no way in which the chemist may synthesize in his laboratory, or the chemical engineer may manufacture on a large scale, the elementary materials, tin, quicksilver, chromium, antimony, or the other mineral elements defined as of this class by the munitions planners. But many of the uses of these commodities, and of the others in the list of 17 "strategic", can be served by substitution in a certain measure, through the ingenuity of research and the skill of engineering. It is particularly true that new synthetics may be substituted for old strategics by such means. Chemical research has lately furnished a conspicuous example of this through the work of Professor Hauser of M.I.T., who has devised a plan for making a synthetic sheet mica from other mineral raw materials, such as bentonite. (See page 65).

The job of the chemical engineer today, as he views the preparedness problem, is to consider whether he and his enterprise may not achieve more of this synthetic replacement, or of substitution by other commodities available in adequate quantity. Already there is great room for enthusiasm as to the progress being made. We have not yet got ready to substitute synthetics for all rubber; nor are the new chemical fibers ready to take the place of natural silk completely. We cannot even claim that we are already fully in position to supply sheet mica, or optical glass, or substitutes for quinine, wool, or manila fiber. But real progress is being made.

Every division of the chemical process industries should study the possibilities of successful, and profitable, work of this sort with respect to the strategic materials and others of the "critical materials" list, for which news interpretation is given elsewhere in this issue of *Chem. & Met.* Perhaps these lists can be shrunk as much in the next ten years as they have been reduced in length by the achievements of the past two decades—remembering that the World War left us a list nearly twice as long. One does not need to be an isolationist, or a high tariff advocate, or even a New Dealer, to wish that such further achievements may soon be made.

COUNSEL FOR THE ASKING

THE CHEMIST ADVISORY COUNCIL, the outgrowth of a temporary, emergency organization, restricted in its field of activity to Metropolitan New York, has just completed its first year of service on a permanent and national basis. With the limited funds at its disposal, the Council has handled more than a thousand individual cases, giving sympathy and encouragement where they have been needed, helping others to help themselves in finding employment, and otherwise doing a most praiseworthy service. If this welfare organization is to continue to function and to serve the unemployed it is going to need financial support and need it soon. It is to be hoped that all employed chemists and chemical engineers, chemical companies, societies and trade associations will do their part to guarantee continuance of this splendid service.

Survival of the Fittest

Just as "natural selection" weeds out the weaker individuals in the animal kingdom, economic selection assures the survival of only the fittest among industrial minerals. From his vantage point as assistant chief engineer of the Nonmetal Economics Division, Mr. Bowles surveys the new competitive trends in the latter field.

OLIVER BOWLES

U.S. Bureau of Mines
Washington, D. C.

FLYING FISH are said to lead an unusually precarious existence. When they take to the air they are beset by feathered enemies; when they seek refuge beneath the waves they are pursued by the equally vigilant inhabitants of the deep. In neither element is safety.

Producers of minerals used as raw materials of the chemical industries are sometimes in a similar state of unrest. They are harassed on the one hand by the more and more exacting specifications of consumers; and on the other hand they are threatened by new competitive mineral products that commonly invade their markets. The chemical and manufacturing industries are in a constant state of change. New inventions, improved processes, or changing requirements of use frequently create demands for new or modified types of raw materials. To meet adequately these changing needs of consumers, producers of mineral raw materials must be constantly alert.

Feldspar and Its Rivals

The feldspar industry affords a striking example of the difficulties that surround producers of industrial minerals. For many years they furnished, with simple equipment and few refinements, an important raw material for the ceramic trade. Gradually the manufacture of ceramic wares became more precise and feldspar producers were called upon to prepare their materials in accordance with definite specifications covering the percentage of alumina, lime and alkalis, and with a strict low limit on iron. They met this challenge promptly. They remodeled their mills, established control laboratories, hired chemists, and thus were equipped to place on the market a series of reliable products with a range of composition adequate for all ordinary requirements.

Although the immediate need was met, feldspar producers enjoyed no lasting repose. Among their customers, particularly those that manufactured glass, a new trend appeared toward the use of a higher percentage of alkaline aluminous fluxes. In consequence, the feldspar industry was confronted with a new competition, that of mineral substances having an alumina content higher than in feldspar. Nepheline syenite, imported from Canada, is one such material. The best of it, when carefully milled, contains about 24 per cent alumina, compared with 16 to 19 per cent for high-grade potash feldspar. Three mills in the United States are now grinding nepheline syenite principally for the glass trade. Some feldspar producers are blending it with their ground spar to increase the alumina content.

With some of their market already lost to nepheline syenite, feldspar producers faced a new competition late in 1938 when another aluminous flux, known locally as "aplite," appeared. This white, massive rock, a large deposit of which occurs near Piney River, Va., is said to contain about 24 per cent alumina, but iron is relatively high and is difficult to remove. Hence, at present, aplite is not regarded as a substitute for feldspar, but rather as a material to be blended with it to increase the alumina content. Care must be exercised, however, to keep the addition of aplite low enough to maintain an iron content in the blended product below the maximum permissible limit. The extent of future competition depends largely on the success of efforts to reduce the iron content of the aplite.

The genius for finding new fluxes has even extended to the utilization of waste products in glass factories. The sand used in grinding plate glass, together with its intermixed content of ground glass, is purified, added to the batch in the furnace and used for making more glass.

Feldspar producers are endeavoring to meet these various competing materials with carefully prepared and accurately blended products of guaranteed composition, products far superior to those sold generally a few years ago.

Competition Among Refractories

History repeats itself. The first iron furnace built west of the Allegheny Mountains in 1802 was lined with blocks of sandstone and in many of the early furnaces this type of refractory was used. About 1865 the silica-brick industry began to expand rapidly. These steam-cured refractories, consisting of a mixture of ground ganister and lime, came into general use, reducing sandstone to very minor importance. Recently interest has been renewed in "firestone," a name applied to carefully selected Ohio sandstone. It gives excellent service in making various refractory linings and is used increasingly.

Manufacture of refractories is a prolific field for development of new materials that compete with the standard, long-established products

such as magnesite, chrome and silica brick, firebrick, and bauxite. Blocks of olivine, consisting largely of the highly refractory magnesium silicate, forsterite, are giving satisfactory service as linings for open-hearth furnaces. At present the industry is small, being confined to a limited area in North Carolina, but it has possibilities for expansion. Kyanite refractories have created a good deal of interest, but they likewise have not attained wide use.

Use of dead-burned dolomite in place of dead-burned magnesite is a substitution well known to metallurgists. When, during the World War, magnesite could not be shipped easily from the Pacific Coast (its only domestic source) and imports were cut off because of a shortage of ships, dead-burned dolomite was used as a substitute in eastern furnaces. This product served the industry so well that many consumers continued its use even when foreign magnesite again became available. Dolomite is, therefore, a keen competitor of both domestic and imported magnesite.

This 20-year-old competition beteween magnesite and dolomite is common-place, but a new and most surprising competitor of both these products has appeared within the past two or three years. It has resources as inexhaustible as the ocean, because the ocean is its source. Two large chemical plants, one at South San Francisco and the other at Newark, Calif., (see *Chem. & Met.*, Sept. 1938, p. 478) are now extracting magnesium salts from sea water in large quantities. By treating these salts with lime derived, at least in part, from oyster shells, also a product of the ocean, magnesia and gypsum are obtained. One plant has a capacity of 60 tons of magnesia per day, which is made into periclase refractories, oxychloride cement, magnesium carbonate for chemical use, and other products, all of which were formerly derived largely from magesite or dolomite.

To state that one can pass a clay suspension through a cream separator and extract a mica substitute sounds like a story from "Alice in Wonderland," but the story none the less approximates the facts. Bentonite suspensions passed through a Supercentrifuge yield minute tough flakes which when compressed will adhere to each other without the assistance of a binder. The strong films thus formed are resistant to water, acids, alkalis and oils and are of such high electrical resistance that they have definite possibilities as substitutes for mica. Prof. Ernest A. Hauser, of Massachusetts Institute of Technology, has announced the discovery of this new product and its development and protection by patents are now in the hands of the Research Corp. of Boston, Mass.

Substitutes for Fullers Earth

Clarification of mineral and vegetable oils is accomplished chiefly with bleaching clay. Fullers earth has long been used, but during recent years the activated or acid-treated earths, usually of the bentonite type, have also been employed. Activated clays are costly to prepare but are several times as efficient as the best quality natural fullers earth. Statistics of bentonite by uses are not available in enough detail to show the quantity used for oil clarification, but it is well known that activated earths are being used increasingly at the expense of fullers earth.

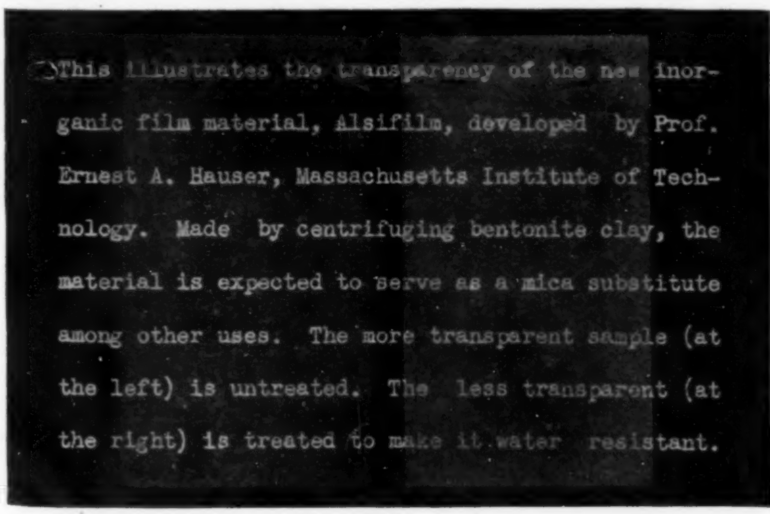
In 1937 a low-grade bauxite high in iron was used successfully as a substitute for fullers earth, and still more recently it has been demonstrated that certain synthetic agents have high decolorizing ability. One of the more important of these agents is hydrous magnesium silicate. The solvent refining processes for lubricating oils have also reduced the demand for bleaching clays. Fullers earth, therefore, is under attack from various angles.

Sulphur From Diverse Sources

In addition to competition between diverse minerals or mineral products that may be applied to the same use, mineral producers must at times face competition from products identical with their own but derived from a different source. Sulphur is a striking example. The Gulf Coast in Louisiana and Texas is the most important source of sulphur supply in the United States, but other sources of supply are becoming strong competitors. Pyrite and pyrrhotite are active sulphur sources, but what may become the keenest competition is that from the waste gases resulting from smelting sulphide ores. The U. S. Bureau of Mines has made important progress in devising practical methods for the fixation of sulphur in smelter smoke; the Consolidated Mining & Smelting Co. at Trail, B. C., (see *Chem. & Met.*, Sept. 1938, p. 483) is now recovering pure sulphur from its smelter gases; recently, Aldermac Mines, Ltd., perfected the Westcott process for recovering sulphur from pyrite and installed a sulphur-recovery plant at Rouyn, Quebec; while in European countries processes for recovery of the element from metallurgical operations and pyrite are used on a large scale.

A rock in Inyo County, Calif., carrying 50 to 80 per cent native sulphur is mined to some extent and furnishes a pure sulphur for western consumers. In some foreign countries sulphuric acid is obtained from gypsum, but for economic reasons this source of supply is unlikely to become important in the United States.

Uncertainties abound in the realm of industrial mineral production. Hence, for self-defense, producers of these minerals must keep in step with every advance in chemical and manufacturing processes which affects the raw materials.



Our Phosphate Reserves

Improved mining and chemical engineering processes and equipment are constantly changing estimates of phosphate rock reserves of this country. Present estimates assure a plentiful supply for the next 65 generations of Americans.

WM. H. WAGGAMAN
Consulting Engineer
Phosphate Rock Institute
New York, N. Y.

WITH THE ADVENT of improved mining methods and new chemical and metallurgical processes, we are continually faced with the necessity of changing our views concerning what constitutes an available mineral asset. Probably no better example could be cited to illustrate this fact than the case of phosphate rock.

A joint Congressional Committee was appointed during 1938 to investigate our phosphate resources, and in these hearings it became evident that previous estimates were based on an obsolete standard.

It was shown: (1) That improved mining methods were bringing into the economic picture phosphate deposits never before considered; (2) that through the application of flotation methods, high-grade phosphate rock was being recovered from low-grade matrix and old waste dumps formerly considered impractical to handle; and (3) that the development of furnace processes and heat treatment methods for rendering phosphates "available" to agriculture had also brought into the picture low-grade deposits which could not possibly have been worked under old conditions.

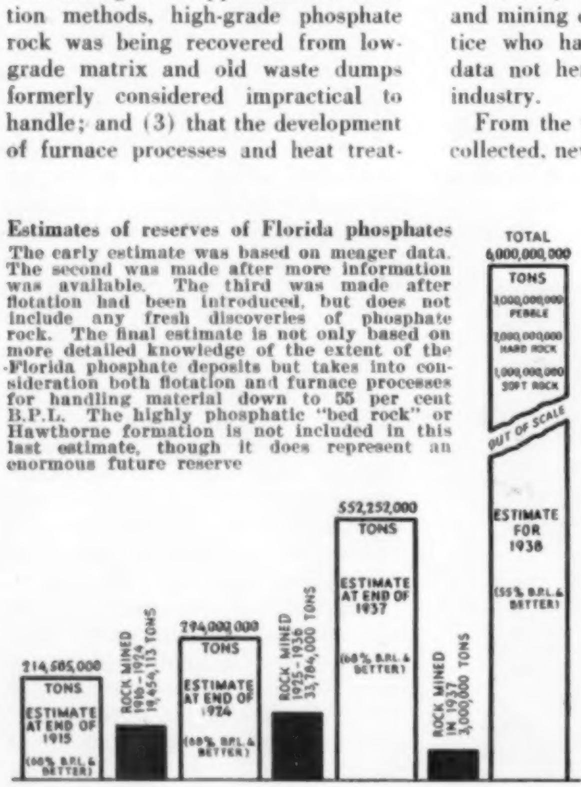
Since miners were in a better position to estimate the tonnages of rock on properties owned or controlled by them, and since they had also examined many other properties throughout Tennessee and Florida, they undertook preparation of new total figures compiled from the data furnished by the individual companies. For this work, they also called in geologists and mining engineers in private practice who had access to prospecting data not heretofore available to the industry.

From the vast amount of data thus collected, new estimates were made of our phosphate reserves in Tennessee and Florida, which ran into rather astounding figures. Although they are regarded as fair and conservative in the light of our present knowledge, the phosphate rock industry has urged that its estimates be checked by established federal and state agencies, and has offered to render such agencies every possible assistance in arriving at the facts.

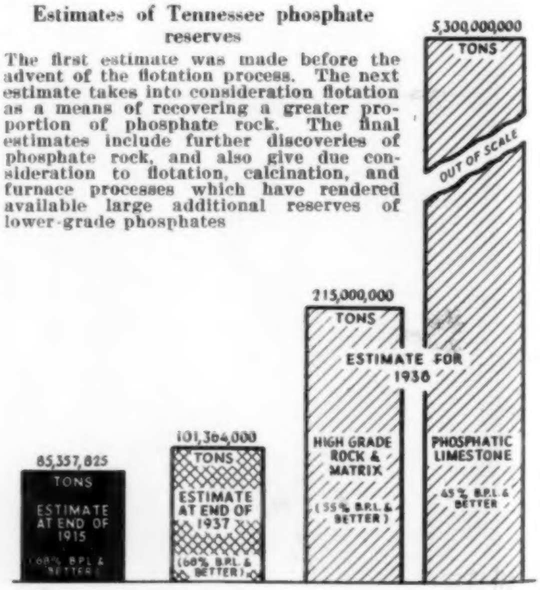
The old estimates of our phosphate reserves were based on rock having a grade of 68 per cent B.P.L. or better, averaging aproximately 70 per cent B.P.L. This standard was employed because rock of this grade was considered suitable for the manufacture of super-phosphate. In making up the new estimate, consideration was given not only to the processes now in use, but also to those which have been demonstrated as feasible, though not generally employed because of present economic conditions.

Representatives of the phosphate industry consulted with Government

Estimates of reserves of Florida phosphates
The early estimate was based on meager data. The second was made after more information was available. The third was made after flotation had been introduced, but does not include any fresh discoveries of phosphate rock. The final estimate is not only based on more detailed knowledge of the extent of the Florida phosphate deposits but takes into consideration both flotation and furnace processes for handling material down to 55 per cent B.P.L. The highly phosphatic "bed rock" or Hawthorne formation is not included in this last estimate, though it does represent an enormous future reserve



Estimates of Tennessee phosphate reserves
The first estimate was made before the advent of the flotation process. The next estimate takes into consideration flotation as a means of recovering a greater proportion of phosphate rock. The final estimates include further discoveries of phosphate rock, and also give due consideration to flotation, calcination, and furnace processes which have rendered available large additional reserves of lower-grade phosphates



experts of the Bureau of Mines, Geological Survey, and the Department of Agriculture, and it was decided that material containing as low as 45 per cent B.P.L. or capable of being beneficiated to this concentration, should be included in our phosphate reserves.

The old and new estimates of our phosphate reserves are given in Table I, and the former and present estimates of our reserves in Tennessee and Florida (exclusive of the phosphorus in the Florida bed-rock) are shown graphically on the facing page.

In Table I, the phosphates in these new estimates are placed in three groups:

1. Phosphate rock containing 55 per cent B.P.L. or more, which can be either used directly for furnace treatment or beneficiated by washing and flotation to give a product suitable for acidulation.
2. Phosphatic limestone containing 45 per cent B.P.L. or more which can be beneficiated by flotation or calcination processes to yield a product suitable for furnace processes or for acidulation.
3. Phosphate in the bed-rock or the "parent limestone" (which is conservatively estimated to contain approximately 35 per cent B.P.L.), and which probably cannot be economically exploited today, but which represents a probable reserve for the future. This is included in Table I, but not in the chart showing the new Florida reserves.

In order to compare the old and new estimates on a common basis, the actual phosphorus contained in these various grades of phosphate is shown in the table.

As shown in Table I, the new estimates of our phosphate reserves containing 35 to 70 per cent B.P.L. are seven times greater than those previously estimated amounting to a total of 51 billion tons. If we calculate the grades of rock included in these new estimates back to the basis of elemental phosphorus, we have a new total reserve of this element of five billion tons as against the previous estimate of one billion tons, which shows that our present estimated reserves of phosphorus are nearly five times as great as previously estimated.

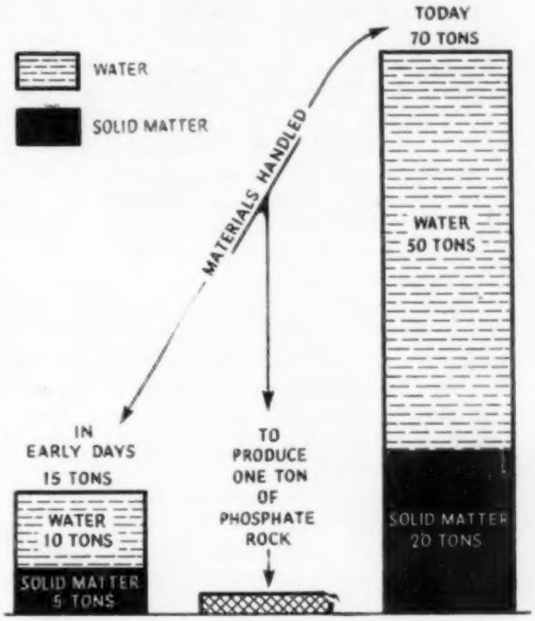
At the present annual rate of production (equivalent to 469,000 tons of elemental phosphorus) our Florida phosphate reserves alone, on the basis of these latest estimates, are sufficient for over 4,000 years, and the total resources in

Table I—Old and New Estimates of Phosphate Reserves

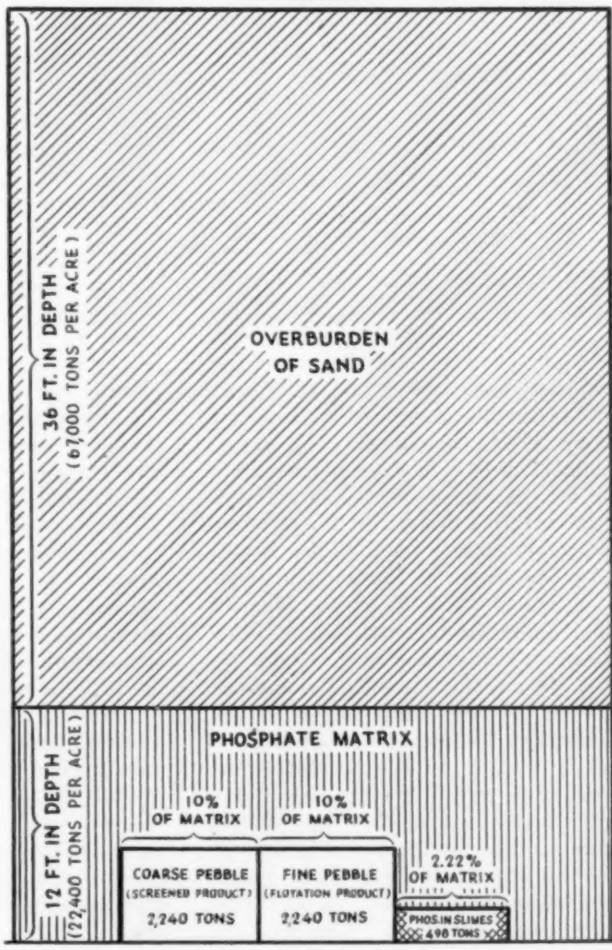
Phosphate Deposits	Old Estimates[1] (In Thousands of Tons)		New Estimates[2] (In Thousands of Tons)	
	Phosphate rock (Basis 70% BPL)	Equiv. to elemental P	Phosphate rock 35–70% BPL	Equiv. to elemental P
Western Phosphates: (Utah, Idaho, Wyoming, and Montana)				
Rock containing 70% BPL	6,569,259	919,696	6,569,259	919,696
Rock containing 55% BPL	....	....	13,138,519[3]	1,445,237
Total western reserves	6,569,259	919,696	19,707,778	2,364,933
Tennessee Phosphates:				
Brown rock phosphate	18,131	2,538	106,000[4]	11,660
Blue rock (70% BPL)	83,233	11,653	86,000	12,040
White rock	....	....	23,000[4]	2,530
Phosphatic limestone	....	....	5,300,000[5]	477,000
Total Tennessee reserves	101,364	14,191	5,515,000	503,230
Florida Phosphates:				
Hard rock	7,686	1,076	2,000,000[4]	220,000
Pebble phosphate	544,566	76,239	3,000,000[4]	330,000
Soft phosphate	....	....	1,000,000[4]	110,000
Bed rock (35% BPL)	....	....	20,000,000[6]	1,400,000
Total Florida reserves	552,252	77,315	26,000,000	2,060,000
Grand total	7,222,875	1,011,202	51,222,778	4,928,163

[1] K. D. Jacob — "Phosphate Rock Reserves of United States," Commercial Fertilizer Yearbook (1938)
[2] Estimates made for Joint Congressional Committee Investigating Phosphate Reserves of United States (Nov. 1938)
[3] According to G. R. Mansfield, Previous estimates of western reserves can be multiplied by 3 if lower grade rock is considered
[4] 55% BPL and better
[5] 45% BPL and better
[6] 35% BPL

Increasing difficulties which must be overcome by the Florida phosphate industry



Pebble phosphate deposit showing present relation of recoverable rock to total material which must be handled



the United States would last for over 10,500 years.

Phosphate mining operations are being conducted today efficiently, economically, and with due regard to conservation. The losses of phosphate entailed under old methods have been largely eliminated, and recoveries of 85 to 90 per cent of the phosphate in our Tennessee and Florida deposits are being consistently obtained by the application of modern mining and metallurgical practices.

When the Florida deposits were first exploited, each ton of recovered rock involved the handling of only five tons of solid matter (overburden and matrix), and approximately ten tons of water (for washing purposes). Today, it is often necessary to handle 20 tons of solids and 50 tons of water for each ton of rock produced. Yet, in spite of mounting difficulties, the cost of production has actually declined, and the price is much below what it was in former years.

The present efficiency of the phosphate industry is illustrated in a drawing which shows a typical pebble phosphate deposit, and the relation of recoverable rock to the total solid materials which must be handled. Twelve to fifteen years ago, such a deposit could not have been economically mined since an over-burden 36 ft. in depth was too heavy to remove, and the only recoverable phosphate was that in the form of relatively coarse pebbles, which, in this case, is only ten per cent of the weight of the matrix.

With the introduction of the electric drag-line, such an over-burden can now be cheaply removed, and the development of the flotation process has made it possible to recover the fine particles of phosphate which were formerly lost. Therefore, such a deposit will yield twice as much marketable product as could have been obtained by the old washing and screening process.

During the earlier hearings before this Congressional Committee, fear was expressed that our exports of phosphate rock were jeopardizing the future of American agriculture in the eastern and southern states. In fact, one of the officials of the TVA stated that, in his opinion, "not a spoonful" of rock should be exported to foreign countries. It is believed, however, that the facts brought out in Tennessee and Florida definitely proved that the prohibition of exports is not only unnecessary, but highly undesirable.

Apart from the fact that our reserves are shown to be amply sufficient to justify a much larger export business, convincing evidence was presented showing that such action would be disastrous to the Florida phosphate industry, and cause far-reaching hardships on the State of Florida.

At the present time, Florida exports, annually, about one million tons of phosphate rock, and in the face of increasing competition from Russia and the French-controlled deposits in northern Africa, it is having a hard time maintaining this modest export trade.

This export tonnage represents, on the basis of the new estimates of the Florida reserves, an annual depletion of less than 0.007 per cent (seven thousandths of one per cent), or, on the basis of our total reserves, a depletion of 0.003 per cent.

It appears, therefore, that in the case of phosphate rock, we can well afford to play the part of the "good neighbor" by permitting nations less fortunate than ours to have a small share of this most plentiful of our mineral resources.

Dynamic Pricing

MILLARD M. RICE
The Brookings Institution, Washington, D. C.

In the hands of the chemical engineer rests no small part of the future of industrial prices even though he may not be concerned primarily with either the pricing or the marketing policies of the products with which he deals. The sound foundation of this statement has been demonstrated, however, in a study of "Industrial Price Policies and Economic Progress" made at the Brookings Institution of Washington under a grant of funds from the Maurice and Laura Falk Foundation of Pittsburgh. The authors of the study are Drs. Edwin G. Nourse and Horace B. Drury.

Briefly, it is pointed out in this study that, under our present industrial organization, management has a considerable measure of control over prices. The old type of competition, in which prices were reached in the marketplace, has given way to new conditions in which executives are able to modify price schedules within limits sometimes narrow, sometimes rather wide. In a large section of industry, production is keyed to prices set in advance at a point calculated to be that at which the product can be bought by an increasing number of people, and a keen competition exists in the effort to turn out the best possible products within that price. Moreover, even in those cases where a concern may have an effective monopoly of a particular product, that product, under modern technical conditions, is likely to meet keen competition from other products that satisfy consumer wants in different ways.

Experiences of the Aluminum Company of America are interesting in this connection. With aluminum prices in 1925 at their highest since the post-war depression, the production of aluminum in the United States was only 140,000,000 lb. as against 138,000,000 lb. in 1920. The automobile industry, which in 1920 had been using an approximate average of 120 lb. of aluminum per car, had by 1925 been so successful in finding substitutes that its requirements per car had fallen to 40 lb. On the other hand, secondary or remelted aluminum which had accounted for only 33,000,000 lb. of the metal coming into the market in 1922 under lower aluminum prices, had by 1925 brought 88,000,000 lb. into the market. This strikingly illustrates the strongly competitive position occupied by aluminum and also the definite check upon the growth of the industry which the high-price policy was exerting.

Between 1925 and 1930 the Aluminum Company showed a reduction in cost amounting to 5 cents per lb. and it is generally understood that there have been further reductions in cost since 1930. Since 1925 the price of aluminum has been reduced approximately 8 cents per lb. With a 20 per cent price prevailing, the amount of aluminum used in 1937 was approximately double that of 1925.

From the chemical industry comes an illustration, which must be anonymous, of the effects of a dynamic price policy upon the growth of an industry and profits arising therefrom. A certain large chemical com-

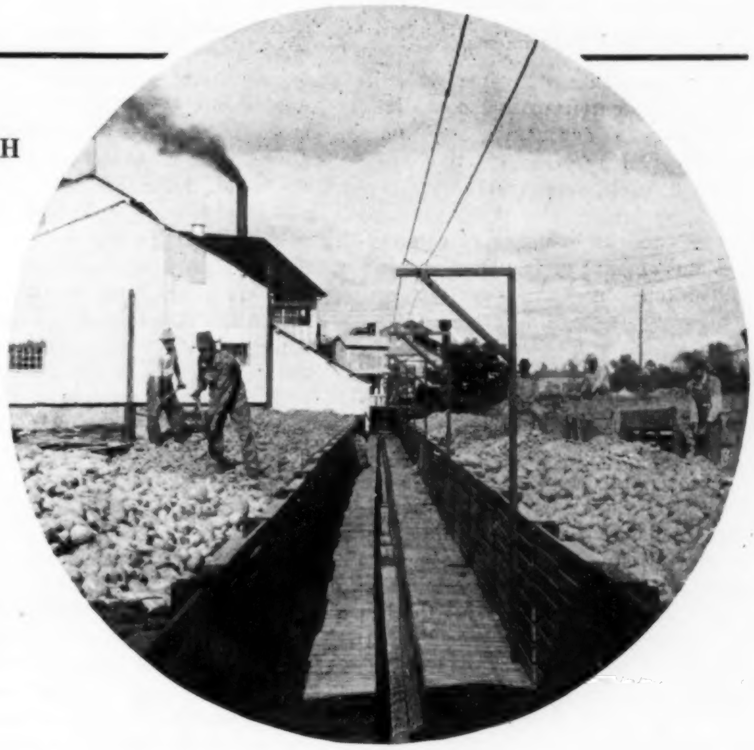
(*Continued on page 86*)

Sweetpotatoes as Raw Material

The means that have been taken to preserve the potatoes so that production of starch could be maintained over a 12-month period and to lower the cost to the manufacturer is a story that has a real significance for numerous industries using agricultural commodities as their starting material.

H. S. PAINE, F. H. THURBER, R. T. BALCH
Carbohydrate Research Division, Bureau of Chemistry and Soils, Washington, D. C., and

W. R. RICHEE
Laurel Starch Factory, Laurel, Miss.



Unloading sweetpotatoes at the Laurel, Miss., starch factory. The conveyor in the center carries the potatoes to the plant

RAW MATERIAL COST is frequently greater than processing cost. Chemical and engineering ingenuity in process development may sometimes be defeated by inability to obtain suitable raw materials at feasible cost. Recent experience of the authors in an endeavor to develop a sweetpotato starch industry in the United States[1] illustrates a situation in which reduction in raw material cost was indispensable.

Development of a southern sweetpotato starch industry for supplying a portion of domestic root starch requirements would have several advantages, such as use of a crop excellently adapted to southern conditions, low transportation cost for raw material and products (consumption of starch in contiguous cotton mills), production of a byproduct feed of high carbohydrate content needed in the South for supplementing cottonseed meal for cattle feed, substitution of sweetpotatoes for cotton in submarginal areas, benefit from greater use of a root crop in crop rotation systems, assistance in solving the cut-over pineland problem (since "sweetpotatoes are particularly adapted to newly cleared lands"[2]), adequate domestic supply of root starch in case of war, and accessibility for coastwise shipment.

The primary problems to be solved were: (1) development of an economical process for obtaining satisfactory yield of starch of high quality; (2) selection and development of suitable mechanical equipment; (3) investigation of the properties of the starch and its suitability for various uses; (4) development of byproducts; (5) devising method of storing sweetpotatoes to permit year-round factory operation; (6) adapting the crop to this new type of use so as to obtain feasible raw material cost. The purpose of this article is to outline the collateral research under (6) which was essential for supplementing chemical and chemical engineering investigations in connnection with the design, erection and operation of a sweetpotato starch factory at Laurel, Miss.

Although sweetpotatoes are the largest vegetable crop in the South, they are grown primarily on a small-plot basis. Low yields per acre (United States average for 1936 was 78 bu.[3]) are due to factors such as growing of low-yielding varieties of smaller size to meet food market requirements and to the seeking of early maturity and harvesting in order to obtain better market prices. The grower has endeavored to obtain a high proportion of U. S. No. 1 grade (a medium size potato of rather uniform shape), which is not always consistent with high yields.

Yet, as later experience showed, it is possible to attain a production of approximately 2 tons of starch per acre in sweetpotatoes in the ground (300 bu. per acre at 23.8 per cent average starch content[4]), as compared

Contribution No. 147 from the Carbohydrate Research Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

with 1.25 tons (in the United States) in white potatoes (262 bu. per acre at 15.9 per cent average starch content[5]) and 1.4 tons in corn (80 bu. per acre at 62.5 per cent average starch content[6]). This favorable comparison in production of starch per acre is the basis of potential non-food utilization of sweetpotatoes, provided this advantage can be carried through agricultural and manufacturing processes and translated into a correspondingly favorable price for the finished starch.

Field Experiments

Since this enterprise involves utilization different from that considered heretofore in agronomic and plant physiological research on this crop, systematic field experiments were conducted by Anderson[7] with reference to factors such as influence of composition and amount of fertilizer on yield and starch content of sweetpotatoes. Comparative tests of different varieties were made with respect to starch yield per acre. Investigations of the rate of storage of starch in sweetpotatoes in relation to various factors showed the advantage of a long growing season for starch production. In the Laurel section the practice now is to plant potatoes during the first half of May. Later plantings have been adversely affected by dry weather in August and September during the last three years, whereas with early planting, a dry period at the end of the season is apparently favorable to high starch content. Even with earlier planting, growers in the Laurel section are able to plant potatoes in the same ground after harvesting truck crops such as spinach. The quantity of fertilizer has been increased profitably to 600–1,000 lb. per acre. Experiments to date indicate that, by a change in spacing and arrangement, the number of sweetpotato plants per acre can be materially decreased without reduction in yield, thus effecting an economy in cost of producing the crop when intended for starch manufacture. Experience in this area indicates that by following recently established practices, yields of at least 300 bu. per acre should be the rule.

Experiments on development of sweetpotato strains of still higher starch content or otherwise greater suitability were undertaken. Thousands of seedlings have been grown by the U. S. Bureau of Plant Industry.[8] Miller has obtained seed from sweetpotatoes under Louisiana conditions and has produced a great number of seedlings in cross-breeding experiments.[9] Solution of the problem of "barren hills" is important for increasing further the acre yield. Such hills, almost devoid of potatoes, may occur alongside hills of abundant yield. Investigation of this problem has been undertaken by Boswell, Steinbauer, Hoffman and Edmund.[10]

Because of its small plot basis and necessity of avoiding bruising (sweetpotatoes heal cuts, but not bruises), this crop has been mechanized to only a minor extent. Industrial utilization would result in growing the crop in large plots, thus permitting use of more efficient planting and harvesting implements which is of great importance for reducing production cost. For starch manufacture bruising is not so objectionable and, hence, this obstacle to mechanization is eliminated. Research for improving mechanical sweetpotato diggers has been conducted by Jones[11] and by Gray, Hurst and Randolph.[12] The latter has made important progress in adapting the combination white potato digger and loader to harvesting of sweetpotatoes. Improvement in machines for setting potato plants is being undertaken.

Value of Vines

Removal of vines is necessary for operating the combination potato digger and loader and this development makes possible a systematic salvaging of the vines (not feasible heretofore), which have good feeding value and are palatable to cattle. The protein, fat and fiber contents of sweetpotato vines (dry basis) compare favorably with those of red clover, crimson clover, cowpea, and soybean hays.[13]

Feeding tests on the residual pulp from sweetpotato starch manufacture showed that it is 95 per cent as valuable for milk and fat production as crushed ear corn and sugarbeet pulp.[14] In feeding tests with beef cattle, steers fed sweetpotato pulp in a mixed ration "made considerably greater daily gains, cheaper gains, shrank less and had a higher drawing percentage than the steers in the other three (comparison) lots. The selling price per 100 lb. (at the National Stockyards, St. Louis, Mo.) was also in favor of this lot".[15]

Black and McComas[16] indicate several factors (including almost complete elimination of cattle tick) which should cause an appreciable increase in the number and quality of cattle in the Coastal Plain States where the byproduct pulp from sweetpotato starch would be principally available.

Sweetpotato pulp supplements cottonseed meal through addition of carbohydrates and renders more effective the utilization of this southern feedstuff which, because of local availability and lack of sufficient carbohydrate feed, is often fed as the principal concentrate in the cattle ration. The dried pulp of the Laurel factory has found a ready market and has been sold principally to dairymen in Mississippi (at $27 per ton). The byproduct from processing sweetpotatoes for starch is thus of reciprocal benefit to agriculture; under some conditions it might be returned to growers in partial payment for potatoes.

The starch factory can operate only about 100 days per year, by using fresh sweetpotatoes. Year-round operation is desirable in order to reduce fixed charged per unit of production. Storage of sweetpotatoes under controlled atmospheric humidity and temperature conditions was not feasible. Furthermore, the sweetpotato is rich in amylase and considerable loss of starch by conversion occurs during storage even at optimum temperature and humidity. Dehydration of sweetpotatoes by ordinary heat application methods is not practicable because of cost and necessity (to prevent gelatinization of starch) of using, during the initial stage, a relatively low temperature range which would permit conversion of starch by amylase. Hopkins and Phillips[17] found that when ground sweetpotatoes are treated with a small proportion of certain reagents (e.g., carbon tetrachloride, carbon disulphide or sulphur dioxide), the cell walls become permeable to liquid so that a large proportion of juice can be eliminated mechanically. Removing juice in this manner at atmospheric temperature is cheaper than evaporating water and makes possible recovery of a large proportion of solubles without dilution. From 60 to 70 per cent of the juice in sweetpotatoes is removed by chemical treatment and pressing, as compared with removal of only one-tenth as much juice at the same pressure from untreated potatoes. Use of factory flue gas to evaporate much of the remaining water which must be eliminated in order to reduce water content to about 12 per cent (at which the potatoes are stable for storage) in conjunction with the byproduct value of the undiluted juice should make possible a low net dehydration cost.

There are various possibilities of utilizing the juice (containing 9.5–11.5 per cent solids and 6.5–8.5 per cent

sugars), including fermentations of different types or concentration to molasses density and mixing with the residual pulp to increase the yield of byproduct feed. Simplification of the starch process with reduction in manufacturing cost is made possible by this preliminary elimination of solubles. An important improvement in the process has been made by using a small proportion of dry, hydrated lime. A pilot plant for working out operating details and mechanizing the continuous dehydration of sweetpotatoes is being erected at the Laurel factory.

Dehydration on the farm as well as at the factory would materially reduce the weight and cost of transporting potatoes to a starch factory. It may be possible to utilize the expressed juice by adding it to sweetpotato vines siloed in trench silos so as to maintain desired microbiological flora (as in use of diluted blackstrap molasses in silos. If sweetpotatoes could be dehydrated on the farm at low cost, it would become possible to put this crop on a stable storage basis which would place it in the same status as corn. This is one of the most important of the factors intervening between the production of starch in potatoes in the ground and the marketing of extracted, purified starch.

Sweetpotatoes are excellent cattle feed and can be substituted for half of the corn in the ration, 3 lb. of (fresh) sweetpotatoes replacing 1 lb. of corn.[18] Farmers in the Laurel area have stated that, in view of the greater obtainable yield per acre of sweetpotatoes, they would reduce corn acreage and increase sweetpotato acreage for feed production if farm dehydration units become practicable.

Considerable research must yet be conducted in order to determine the feasibility of farm dehydration of sweetpotatoes. If this can be accomplished on a satisfactory basis, it may lead to increased production of sweetpotatoes for feeding purposes. Mass production of sweetpotatoes would tend to lower production costs and would be favorable to utilization for starch manufacture. With dehydration on the farm and use for feed, the situation of this crop in the South would be comparable to that of corn in the North. In both cases, utilization for manufacture of starch and derived products would be accessory to use as feed on the farm, and sweetpotates in the South would be, in many respects, a counterpart of corn in the Middle West.

Some of the research problems indicated have been solved and others are only in process of investigation. There is evidently much latitude for accomplishing by research a material reduction in the net cost of producing and harvesting sweetpotatoes. This results primarily from a radical change in viewpoint and in requirements when the crop is utilized for starch manufacture instead of for food. The margin for reducing raw material cost with change in type of utilization undoubtedly varies from one crop to another but, when changing from food to non-food use, it is probable that the change in cost is generally in the direction of reduction. It is evident that the interests of agriculture and of industrial processors of agricultural commodities are, in many ways, mutual and that research applied to crop production may benefit both. Benefits, such as those indicated, may accrue to agriculture from: (1) expanded markets; (2) improvements in methods of handling crops; (3) new farm byproducts; (4) byproducts of processing the crop which are available locally and which meet an agricultural need.

References

(1) *Ind. Eng. Chem.*, **30**, 1331.

(2) Miller, F. E., U. S. Dept. Agr., Farmers' Bull. **999**, 2 (1919, revised 1927).

(3) U. S. Dept. Agr., Agricultural Statistics, 1937, p. 197.

(4) With reference to selection of 23.8 per cent starch content and 300 bu. yield per acre cf. *Ind. Eng. Chem.*, **30**, 1331.

(5) 262 bu. per acre = av. yield for 10 yr. period, 1927-1936, in Maine and 15.9 per cent = typical av. starch content of white potatoes in Maine for 1930-1938 (communication from C. A. Brautlecht, University of Maine, Orono, Me.).

(6) "In favorable growing seasons yields of 80 bu. of corn per acre are not uncommon in the Corn Belt" (communication from Merle T. Jenkins, Principal Agronomist in Charge of Corn Investigations, Bureau of Plant Industry, U. S. Dept. Agric.); relative to figure of 62.5 per cent av. starch content in corn cf. "A Comprehensive Survey of Starch Chemistry," R. P. Walton, p. 130 and "Starch Making," Felix Rehwald, p. 169.

(7) Anderson, W. S. (Miss. Agric. Expt. Station), *Proc. Am. Soc. Hort. Sci.*, **33**, 449 (1936); **34**, 709, 713 (1937).

(8) Seedlings grown from seeds obtained through cooperation with the Puerto Rican, Hawaiian, and one of the Cuban Agricultural experiment stations.

(9) Dept. Horticulture, Louisiana Agr. Expt. Sta., Baton Rouge, La.

(10) Boswell, Steinbauer and Hoffman of the Bureau of Plant Industry, U.S.D.A., and Edmond of S. C. Agr. Expt. Sta.

(11) Miss. Agr. Expt. Sta.

(12) Bureau Agricultural Engineering, U. S. D. A.

(13) Keitt, *S. C. Agr. Expt. Sta., Bull.* **165**, (1912).

(14) Miss. Agr. Expt. Sta., Information Sheet, Livestock Field Day, May 7, 1935; St. Louis Daily Livestock Reporter, "Is Sweet Potato Pulp New Cattle Feed for Southland?", April 5, 1935.

(15) Moore, J. S., and Cowsert, W. C., Miss. Agr. Expt. Sta., Information Sheet 77 (1935).

(16) Black, W. H., and McComas, E. W., Beef and Dual Purpose Cattle Investigations, U. S. Bureau Animal Industry, personal communication, Oct. 27, 1938.

(17) Holders of fellowships contributed to Carbohydrate Research Division by The Chemical Foundation, Inc.; cf. *Science*, **87**, 71 (1938), and U. S. public service patent No. 2,137,890.

(18) From replies to questionnaire addressed to southern agricultural experiment stations.

Continuous, roller type, dewatering press in which the rolls are forced against filtering drum

Starch dryer, of batch vacuum type, with a finished starch load of 3,000 lb., drying cycle 2.75 hr.

New Chemicals Used in Leather

In recent years the leather industry has become increasingly important as a consumer of chemicals. Mr. Smith, author of "Principles of Light Leather Manufacture," tells how chemical industry has analyzed the tanner's needs.

PAUL I. SMITH
Leather Technologist
Leighton Buzzard,
Bedford, England.

TODAY THE LEATHER INDUSTRY may be inclined to favor the use of chemicals which are likely to speed up production or improve the quality of leather products. Chemical industry, realizing this fact, is making a determined bid for increased business from tanners. Many chemical companies have organized special divisions or departments for the study of tannery problems in an effort to utilize new chemicals. Some of the recent discoveries, arranged by the leather operation in which they are involved, are discussed below.

Hide Preservation—Bacterial and insecticidal attacks are prevented, in some cases, by natural saline materials consisting of sodium sulphate and earth or by common salt. However, several chemical cures are receiving increased attention. Among these are the arsenic cures consisting of white arsenious oxides dissolved in soda solution, and the metallic naphthenates. The latter salts, particularly that of copper, are well worth consideration as they can be made into excellent emulsions and possess good fungicidal properties. Present English practice seems to indicate that copper naphthenate emulsions may prove more effective and more economical than the antiseptics usually recommended, such as phenol, sodium bisulphite, etc.

Depilatories and Swelling Agents—Sodium sulphide is now widely employed in place of realgar because it is cheaper and acts more quickly, although it does not always produce the best results. In recent years a considerable amount of interest has been aroused by the use of proteolytic enzymes in conjunction with alkalis based on the discovery of Dr. Rohm in 1913. Recent work by Rohm indicates the usefulness of fungic tryptases from types of aspergillus used in conjunction with alkali nitrates.

British patent 472,973 describes a method whereby the skins are softened with sodium sulphite and carbonate prior to the enzyme bath. After enzyme treatment the hair is removed and the goods worked in a weak alkaline bath made up of sodium carbonate. Hydrosulphites, sulphoxylates, or their organic derivatives are recent additions to a straight depilatory made of lime or caustic alkali and B.P. 487,097 mentions their use in conjunction with both arsenic and sodium sulphides as well as proteolytic enzymes.

Bating of Hides—Pancreatic enzymes in the presence of ammonium salts or other suitable weak alkalis are now used almost exclusively. However, good results can be obtained by the addition of alkali metal polyphosphates, pyrophosphate or metaphosphate to the bating enzyme, and the pH of the solution maintained at 7.4. A patent by A. H. Stevens (Hall Laboratories, Inc.), B.P. 471,753, describes the process in considerable more detail.

Tanning Materials—Although vegetable tanning extracts are still used for the most part, increased emphasis is being placed upon synthetic materials. Generally these are sulphonic acid condensation products and they are widly used for the preparatory stages of tanning and also for bleaching leather. Their chemical composition is exceedingly complex. A patent taken out by Geigy A. G., B. P. 465,674, states that such tanning agents may be prepared by heating a mixture of naphthalene sulphonic acid, dioxydiphenyl sulphone, formaldehyde and water to boiling and neutralizing with water glass and caustic soda. Other synthetics are being made by reacting chlorophenol with sulphonic acid and treating the product with formaldehyde.

Sulphite-cellulose waste liquors are also used as a source of cheap tanning materials after the calcium salts have been removed by treatment with lime and sodium carbonate, sodium carbonate alone, ammonia or ammonium salts. Recent research on these liquors indicates that the best tanning extracts are prepared by the ammonia method. A number of patents have been taken out recently, particularly in Germany, covering the production of special tanning agents from sulphite-cellulose lye. I. G. Farbenindustrie (B. P. 481,572), obtains new tanning agents by the interaction of ligninsulphonic acid or its salts, or sulphite-cellulose lye, by an aromatic hydroxy compound containing either a single aromatic nucleus or two or more aromatic nuclei directly connected, and formaldehyde. The reaction is effected under such mild conditions that no water insoluble products are formed. In the examples given, sulphite-cellulose lye, cresol and acetaldehyde are condensed in the presence of hydrochloric acid. These sulphite-cellulose materials are seldom used alone. Usually they are used as a pre-tannage to be followed by either vegetable or synthetic tannins.

Polyphosphates, $Na_5P_3O_{10}$, $Na_6P_4O_{13}$, $Na_{12}P_{10}O_{31}$, are now being used for tanning, either alone or in combination with other tanning materials. Sodium polyphosphate of the composition $Na_{12}P_{10}O_{31}$ is employed in conjunction with water glass, the pH of the solution being gradually brought to 2.5 by the addition of acid. This method is fully described in B. P. 484,781. Zirconium oxychloride also

is being used now as a pre-tannage.

Some progress has been made with iron tannages in Germany, where the use of high molecular weight compounds is favored. Products such as hexaurea iron chloride are mentioned in current patents and they are used in conjunction with ordinary sulphonic acid condensation products. Experience and research have shown that the more complex the iron salt molecule the greater the resistance of the resultant leather to oxidation and decay. It should, however, be stressed that it is Germany's economic policy of self sufficiency that is encouraging manufacturers to turn to cheap iron salts as sources of tanning materials. In normal times these new substitutes for chromium salts and vegetable extracts would not be used. Alkali-metal polyphosphates such as sodium metaphosphates, are also useful for mordanting chrome-tanned leather so that it will dye well with ordinary basic dyes.

Leather Finishing—A good deal of attention is now being given to the claims of ethyl and benzyl cellulose for the finishing of leather. The former is particularly important because of the excellent flexibility and good breaking strength of its film when compared with nitrocellulose, and because of its good water resistance when properly plasticized with raw castor oil and other materials. Ethyl cellulose is being used not only as a foundation for straight lacquers, but also incorporated with natural and synthetic waxes in the manufacture of wax finishes and water-bound pigment dopes. Notable progress has been made with the softer acrylic ester polymers for the finishing of morocco and good grade fancy leathers and upholstery. These synthetic products adhere exceptionally well and the thin films have a high and permanent flexibility. What is more important from the sale standpoint is that the new finishes give the grain a soft and natural feel. Unlike nitrocellulose lacquers, they do not give the leather an artificial or doped appearance. Aqueous dispersions of the resin are generally preferred to solvent solutions and they can be applied with a spray gun or brush. Acrylic resins are likely to be used extensively in the manufacture of white sports leather because, unlike nitrocellulose, they show no tendency to turn yellow when exposed to strong sunlight for long periods. White pigments, such as titanium oxide which is slightly acidic and liable to react with the finish, has no effect on the stability of the esters. In the automobile field, leather finished in this way should be very acceptable, as it is more resistant to grease, gasoline and dirt than ordinary nitrocellulose finished leathers.

Chlorinated rubber as a leather finish is receiving serious consideration; however, several difficulties have yet to be overcome before it can be used on a commercial scale. It is essential that the adhesion of the rubber in solvent solution to the leather should be improved and made more permanent. Further developments will most likely lie in the direction of compounding chlorinated rubber with chlorinated naphthalene and other synthetic and natural waxes.

In Germany resins of the polyvinylchloride type, Mipolam and Astralon, are now being used as finishes for upholstery work. These new plastics are non-hygroscopic, resistant to many chemicals, greases and solvents and their films are flexible and strong.

Proofing of Leather—Complex organic compounds, such as amides of amino-carboxylic acid, are being used for mothproofing. A material obtained by reacting monomeric propylethyleneimine with epichlorhydrin has been patented by I. G. Farbenindustrie. The thianthrenes are also used for the same purpose and a range of nearly 26 compounds is mentioned by Geigy A. G., B. P. 467,701.

The demand for fire-resistant leathers is not very great. It is difficult to achieve permanent and reliable results. The best products are likely to be obtained by forming insoluble aluminum compounds in the actual pores of the tanned leather. A patent by M. C. Lamb, B. P. 465,533, describes a process whereby degreased leather is first drummed with aluminum sulphate and then with the addition of sodium phosphate.

Drum tanning with blended vegetable extracts and the new synthetic tanning materials is now a general practice

Spray finishes of the cellulose nitrate lacquer type are now in wide use in most light leather tanneries

Private Water Carriers Cut Costs

Recent extensions of navigable streams, and improvements in design, construction methods and metals have made this means of transportation more attractive than ever before. And distribution offers the greatest opportunity for reduction of delivered costs.

By T. D. BOWES
Naval Architect and Engineer
Philadelphia, Pa.

Package delivery, diesel freighter expedites quick unloading and picking up of small package freight at different points

The chemical industry has been so engrossed in developing and perfecting products and processes that it has sometimes overlooked the necessity of getting its products into the hands of the consumer at the lowest possible delivered cost. And in the final analysis it is the consumer who controls the volume of business that the manufacturer will receive and consequently his profits. Not only is it important to reduce manufacturing costs as far as possible, but distribution costs too must be likewise treated, and from what has been observed this is not always being done. In many cases transportation costs may be further reduced by the use of methods that are at present available to management. Where plants are located on or near navigable water it is quite possible that private water carriers are the answer to the problem. Recent extensions in navigable streams, and improvements in design, construction methods and metals have made this method of transportation more attractive than ever before.

The fact that a private carrier can be specially designed and constructed to handle an owner's incoming raw materials and outgoing products in the best manner possible makes it a specialized tool for a specific purpose and, therefore, the most efficient. The public carriers cannot compete with the private carrier for a specific product as their equipment must be designed to handle all types of products. It is a case of the single-purpose tool against that of the tool for all purposes.

Several examples of savings that have been made in the transportation of raw and finished materials by the use of private water carriers are given below.

A manufacturer has 60,000 tons of cargo to move each way or a total movement of about 125,000 tons, over a total distance of 13,200 nautical miles. This would cover trips from New York or Philadelphia to the east or west coast of South American, the West coast of North American or the Hawaiian Islands.

For this purpose a specially designed diesel propelled, hopper type cargo vessel was selected that would carry about 4,400 tons. Such a vessel is not only low in capital cost, but it is economical to operate and can be loaded and discharged cheaply and quickly. Three eleven-knot vessels of this type were required.

Capital invested........	$1,452,000
Total operating cost, including 3% interest and 20 year depreciation	$618,313
Cost per ton..........	4.95
Cost per ton public carrier	$11
Total cost public carrier	$1,375,000
Saving by private carrier	$756,687
Return on capital......	52.11%
With 3% interest in fixed charges	55.11%
In fixed charges there is a 5% depreciation set up, so with this the investment can be written off in........	1.66 yr.

In another example the plant is located 50 miles from navigable waters and 600 miles from raw materials which are on water. This manufacturer will move 64,500 tons of raw materials and 20,000 tons of finished products as a back haul. The water movement will be all inland, part in shallow water and part in deep water. To handle this shipment a diesel self-propelled barge of 1,850 ton-capacity would be used, an unloading terminal constructed near the finished product plant and trucks to carry the cargo

from the unloading terminal to the plant. The necessity for constructing an unloading terminal is due to the fact that a large railroad controls the nearest marine terminal and demands a price of $1.25 per ton for unloading. By building and operating a terminal the same work can be done for less than 20 cents a ton, including 5 per cent depreciation and 3 per cent interest.

Capital investment in vessel..	$286,600	
Capital investment in terminal	67,400	
Capital investment in trucks —8 hr. basis............	90,000	
	$444,000	
The operating cost would be as follows:—		
Operating cost of vessel.....	$77,690	
Operating cost of terminal..	13,580	
Total—ready for truck haul	$91,270	
or, per ton................		$1.08
Operating cost of trucks....	$99,710	
or, per ton.................		$1.18
Total cost per ton by private carrier and truck.........		$2.26
Railroad rate per ton.......		$7.40
Public water carrier and truck per ton............		$4.08
Total saving over public water carrier and truck.........	$153,790	
Return on investment from savings		35%
With 3% in fixed charges..		38%

Another case is that of a manufacturer, who moves approximately 3,000 tons of raw materials to his plant every 6½ days and ships 1,000 tons as a back haul. The distance to be covered is about 400 nautical miles, all inland—part in shallow water and part in deep water. Fifty trips per year will be made, so that 150,000 tons of raw materials and 50,000 tons of finished products will be carried, making a total of 200,000 tons handled per year.

To carry out this project, it was decided to build a large hopper barge, about 275 ft. long, that could carry, if necessary, 3,300 tons on about 10 ft. draft and tow it with a 650 boiler horsepower diesel tow boat. This combination has worked successfully.

The figures on such equipment would be as follows:

Slings and miscellaneous equipment	$21,000
Barge	78,000
Tow boat	140,000
Total Capital.............	$239,000
Operating cost, water	$93,349
150,000 tons by public carrier at $2 per ton..............	300,000
50,000 tons by public water carrier at $1 per ton........	50,000
Total cost by public carrier	$350,000
Less operating cost...........	93,349
Saving	$256,651

We might now take the case of the manufacturer, who delivers one kind of chemical to another manufacturer and takes back another for his own use as well as fuel and other supplies on the way. For such transportation a combination towboat tanker and a hopper barge would be used. The total tonnage moved is about 60,000 tons per year. The total distance each way is 460 nautical miles. The tanker travels the entire distance and the barge is only towed 260 nautical miles. The chemicals that are carried must be kept absolutely pure, so that when they are carried by a public carrier they must be in lined cylinders that are cleaned at the end of each run. The tanker can have its compartments lined with nickel or other corrosion-resistant material to prevent contamination and the cargo pumped ashore at each end of the run, thus saving the tremendous cost of handling large cylinders. The costs would be about as follows.

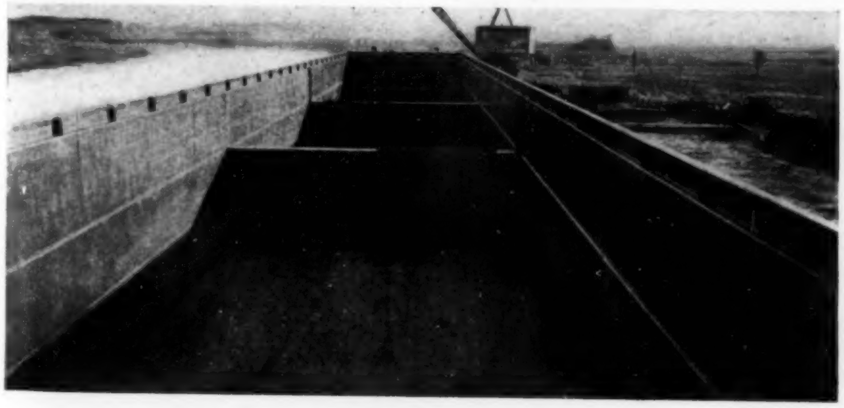
Tanker tow boat.................	$126,000
Hopper barge	42,000
	$168,000
Tow-boat tanker direct........	$28,500
Barge direct	4,600
Insurance	4,800
Depreciation	8,400
Interest 4%	6,720
Total operating cost......	$53,020

The present method using public carriers would cost in excess of $200,000, so that a little over a year's operation would pay the capital back.

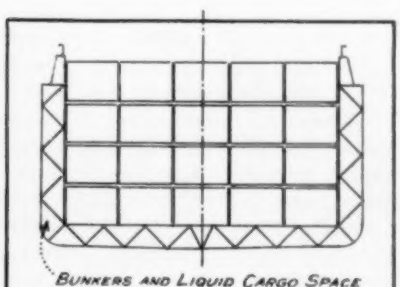
In all the examples given above no account has been taken of taxes or overhead, as it was assumed the same traffic department handling the present shipments could handle the private operations.

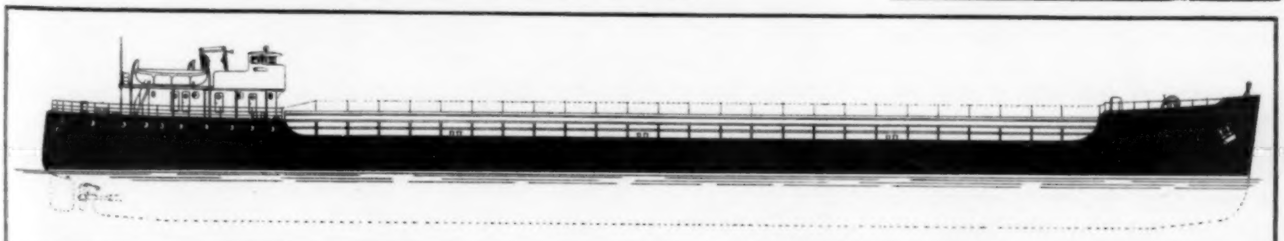
These comparisons of the costs of transporting chemicals by private and public carriers may suggest to some other manufacturer how his costs can be reduced.

This hopper barge will handle a cargo, which would require 70 or 80 cars



An ultra-modern, efficient means of moving bulk cargo





Tremendous Trifles

Often the courier of stories of abounding chemical success,* Chem. & Met. *now presents for the first time an article dedicated to those ventures which were not so successful. This is done with the sincere hope that these errors will enable others to avoid similar pitfalls on the road to fame and fortune.

NEARLY ALL OF US have some kind of a hobby—a secret passion for collecting things. Chester Penning, for example, has long been interested in studying some of the little things that make for big failures in chemical industry. During more than 20 years of association with governmental and private enterprises he has found many interesting examples of important industrial developments that have failed or have been seriously retarded because some economic or technical factor had been neglected. Because such cases usually have a lesson in them for all chemical engineers—young and old alike—I have asked him to share his "collection" with the readers of CHEM & MET. *This he does in a most engaging way in this article.—Editor.*

CHESTER H. PENNING

CHEMICAL LITERATURE is replete with accounts of great successes —millions made by the "magic of chemistry." Story after story is spread over the printed page, in the Sunday supplements and in the financial sections, so that the ordinary man in the street has come to think of the science of chemistry as being one sure way to riches. No doubt this has had considerable to do with the large increase in the number of students in chemical courses throughout the nation.

But what of the failures—for we who have dug a little beneath the surface of all this glamour know there have been a few at least. Where are the stories of the operations which looked so beautiful on paper, and even in the pilot plant, but couldn't make the grade when transferred to large-scale production? One has to dig deep, and often in strange places, to get the obituaries. It was with the thought that some of these might prove of interest, and perhaps instructive, that the writer attempted to collect the few which are here presented.

A classic in the paper industry is the story of the White Mountain Paper Co., organized in 1901 by a group of bankers who proceeded to build at Portsmouth, New Hampshire, what was intended to be the largest paper mill in the world. It was incorporated with a capital of $15,000,000 and the owners proposed to erect a 20-machine plant with a capacity of 200 tons of newsprint and 300 tons of book paper daily. Power requirements were 40,000 hp. half of which was to be water power. In the April 23, 1903 issue of the *Paper Trade Journal* appears an article telling of the appointment of a receiver for the organization. The plant was reported to be 65 per cent completed. One of the bankers, interviewed, said "The application for a receiver is a friendly matter looking to the reorganization of the company. This move was made necessary because those best informed in regard to financial affairs realized that the White Mountain Paper Co. was not properly financed. To remedy the defects of the original financial plan is the reason for the receivership."

In September, 1904, another group of bankers took over the property, but before the end of that year it had been transferred to still another group, organized as The Publishers Paper Co. In its December 22 issue of that year the *Paper Trade Journal* quoted the new president as follows: "The confidence of the successful operation of the mill is attributed to the result of recent experiments which are said to have demonstrated the practical use of salt water for washing purposes in paper mills. Experiments have been going on for three months. Assuming that salt water can be so treated the new company will go ahead without the necessity of relying on the 14-mile pipe line the construction of which was so costly to the old White Mountain company."

Here we have the real reason for the failure. Having no fresh water available, it was proposed to use salt water. The late Dr. Arthur D. Little told the story to a different group of bankers in 1923.* With the buildings all up and the machinery contracted for and largely in place, the president of the company called in Dr. Little and somewhat casually asked him if he thought the salt water would cause them any trouble. Quoting Dr. Little: "When I told him of the insuperable difficulties that would be encountered he was incredulous and hurt. The plant stands idle today, a $10,000,000 monument to ignorance of elementary chemistry."

One wonders how such a thing could happen. Was there no one connected with the organization suffi-

*The Chemistry Behind the Dollar—an address delivered at the 30th Annual Convention of the New York State Bankers at Atlantic City, June 13, 1923, privately printed by Arthur D. Little, Inc.

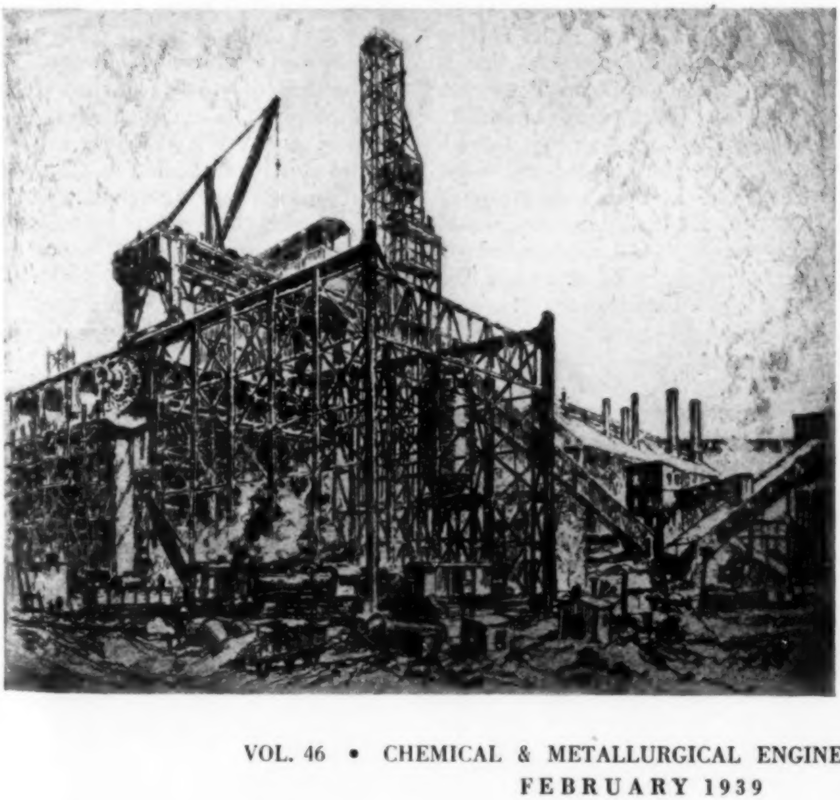
ciently acquainted with the requirements of paper manufacture to think of inquiring about the supply of fresh water? The president who consulted Dr. Little must have had some misgivings, though apparently he thought it of not much importance. But the 14-mile pipe line required to bring this little item to the plant was the added expense that brought on bankruptcy. It is understood that the plant did operate for a short time with salt water, but the paper made was of such poor quality that it could not be sold. In spite of warnings from Dr. Little they did sell some wrapping paper to one of the big hardware companies and let themselves in for a costly lawsuit because the paper rusted and blemished the hardware which was wrapped in it.

There is said to be another paper mill built in Nova Scotia under the same circumstances; nothing can be found in print about it. Then there is the mill in India built to make paper from bamboo. Some excellent paper was made in the pilot plant, but soon after the large-scale operation was started it was found that the silica contained in the nodules of the bamboo built up an extremely hard encrustation in the evaporation tubes of the recovery system. It was impossibly expensive to remove this deposit at frequent intervals and also too expensive to remove the nodules from the bamboo. Consequently the mill was shut down and later converted to another purpose. Paper is now successfully being made from bamboo both in India and elsewhere but the little oversight of the presence of the silica cost the first producers their entire investment.

Low-Temperature Carbonization

Coming down to more modern times, we have the story of the low-temperature carbonization of coal—an idea originated in Germany, on which over $50,000,000 was spent in the United States alone. A large part of this was spent in one uneconomic experiment which proved a serious burden on a large corporation that had been the leader in its field. This company organized a subsidiary that built eight retorts to carry out in this country the process which apparently was being very successfully worked in Germany by the Kohlenscheidungs Gesellschaft. There seemed to be much to recommend it. In addition to the obvious advantages of operating at 1,000 deg. F. instead of 2,000 deg., the coke produced gave a quick fire which would hold for a long time and could easily be revived—an ideal domestic fuel, especially for fireplaces. The yield of gas was lower than from high temperature coke, but the yield of tar was at least twice that from regular coke oven operation. What was the trouble?

Building a huge but unsuccessful plant for the low-temperature carbonization of coal. Here many millions of dollars were spent to test the economic possibilities for processing bituminous coal by a German method. It failed primarily because it could not find a profitable and balanced market for all its products and byproducts



According to the account given by Dr. Roland Soule in a paper presented before the International Conference on Bituminous Coal in 1931,† (one of the few such stories to be found in print) there was nothing but trouble from the start to the conclusion of these operations. In high-temperature coking the coal shrinks and thus can readily be pushed from the oven. At 700 deg. to 900 deg. F. it becomes a sticky mass—impossible to remove by the usual method. Because coal is a poor conductor of heat, the outside layers became incandescent while the inside remained unaffected, thus requiring the use of thin layers with increased equipment costs or the introduction of mechanical agitation. Coke thus produced was also extremely reactive, frequently catching fire subsequent to quenching.

Another idea was to accomplish complete gasification of the coal in a structure like a blast furnace—feeding coal in at the top, pumping air in at the bottom. The hot producer gas formed in the lower section would rise and accomplish a simple and inexpensive low-temperature carbonization by giving its heat to the descending coal. It was found, however, that conditions right for carbonization were not right for gasification. In wide diameter retorts the fuel movement was hopelessly irregular. The charge, becoming sticky, hung on the walls, and the raw coal funnelled through unchanged. It was necessary to cause small explosions in the retort to dislodge the charge—even dynamite being required in occasional instances.

Next Came "Bubble Coke"

A third idea was to use powdered coal as the raw material. Laboratory experiments indicated that the time required for coking could be reduced to a few seconds instead of 12 to 14 hours. When the coal was distilled in the form of a moving cloud a prod-

†*Trans. Int. Conf. on Bit. Coal*, 1, 272-338, 1931.

uct known as "bubble coke" was produced. It had a porous physical structure, quite soft, was readily pulverized and less abrasive on hammer mills than coal. Used in place of powdered coal as a fuel, its high ratio of surface to mass resulted in rapid combustion and low carbon content in the fly ash. It flowed through small orifices like sand in an hourglass. It had none of the tendency of pulverized coal to choke and flood the burners.

Operating Expense Too High

Despite the tremendously reduced operating time, the investment and operating expense of the process were found to be too high. For one thing the heat transfer was not sufficiently improved to bring overall costs to the necessary low level. The plant could not operate continuously when external heating was used because the coke built up on the walls and soon plugged the exit. Better results were obtained with internal heating, but still plastic coke formed on the walls and internally heated ovens 100 ft. high proved less efficient than externally heated stacks 20 ft. high. Fly dust from both types plugged the cooling equipment; the pitch and tar formed held nearly all of it. Water shower recovery was uneconomical because it complicated the tar recovery system. The cooling problem on the fluffy mass of coke was also quite difficult.

High Hopes for the Tar

But despite all these discouragements with gas and coke, efforts were continued because of high hopes held out for the tar. The double yield and high content of phenolic compounds were expected to compensate for all of the disadvantages in process and products mentioned above. In every proposed application, however, some discouraging disadvantage appeared. Low-temperature tar is a mixture of phenols and hydro-carbons. The hydrocarbons are largely non-aromatic, unsuited for the manufacture of the usual benzene, napthalene and anthracene intermediates. This portion of the tar, however, is relatively unimportant from the standpoint of income, for even in high-temperature tar the portion used for intermediates accounts for less than 5 per cent of the distiller's earnings. The most important single coal tar product from his standpoint is creosote oil, used as a wood preservative, and the most important portion of this is in the benzenoid content. Low-temperature tar has no benzenoids, but its phenolic content gives it ten times the toxicity of high-temperature tar for wood preservation. Multiply this by two to represent the double yield, and the high hopes of the low-temperature advocates appear justified.

Marketing the product, however, was not so simple as it seemed. The official specifications for wood preservatives, on which all purchases are based, are founded not on the effectiveness of the material but on its identity. These specifications can be met only by a creosote obtained from high-temperature tar. They were purposely so drawn in order to bar less toxic water-gas and petroleum products. All attempts to modify them thus far have failed. The wood pickler as a rule is not of a scientific mind; both he and his customers demand service tests on new products, with a 20-year minimum the rule. The wood-chemical industry has for years been trying to break into this market, and the petroleum industry is working with suspensions of inorganic poisons in petroleum derivatives, so that eventually the specifications will undoubtedly be revised—but much too late to help the low-temperature carbonizers.

They next turned to the disinfectant market as an outlet for their tar. Tests showed it to produce an excellent sheep and cattle dip. When mixed with water the phenols gave a pink solution. This was not to the liking of sheep dip users, who were accustomed to white emulsions and would not use the pink in spite of the fact that it did not dye the sheep's wool nor even stain the woodwork of the tanks. To them white indicated purity. Investigation disclosed that the red color came from a small percentage of compounds related to dihydrocatechol which turned red on exposure to alkali. Elimination of this color destroyed a great deal of the disinfecting value.

Then They Tried Plastics

The remaining large field was in plastics, but with all of the phenols in the tar being higher-boiling than cresol, no molding powder could be produced that was not hopelessly long-curing. Even that portion of the cresols which was in the same boiling range as that from high-temperature tar was slower curing than the high-temperature products because of a higher ratio of *para* to *meta* compounds in the low-temperature product.

During the ten years through which this work was continued there were many developments elsewhere that helped this company along the road to ruin. Long-distance gas and oil lines brought smokeless and ashless fuel at relatively low cost to several districts where the low-temperature carbonization process originally appeared to have the best chance of economic survival.

Thus endeth the story of a giant corporation, that was influenced to pour millions of dollars into a process that looked good from a purely technical standpoint but failed because it could not profitably market all of its products and byproducts.

Jersey Potash Plant

Another example of a lost cause was a potash plant built shortly before 1920 on the shore of the Raritan River near New Brunswick, New Jersey. It included as an essential part of the process what was then the largest lime plant in the world—ten rotary kilns each 8 ft. in diameter and 125 ft. long. Hot lime from these kilns was cooled in rotary coolers, then slacked with an excess of water. Lime slurry so produced was pumped to autoclaves operating at 470 deg. F. under high pressure, there being mixed with the potash — containing New Jersey greensand—the mineral glauconite, $KFeSi_2O_6.H_2O$, ground so that 90 per cent passed a 200-mesh screen. Approximately three-fourths of the 6 to 7 per cent K_2O in the sand was converted to caustic potash. The heat in the converted slurry was removed in slurry boilers which generated steam for the plant. The cooled slurry was filtered and the K_2O liquor concentrated to 45 deg. Bé. in Manistee quadruple-effect evaporators, then to 90 per cent K_2O in oil-heated iron pots. It was of high purity, since the sand contains only traces of sodium, being totally unlike other potash-bearing minerals in this respect. The chloride and sulphate content was also low.

Before constructing this tremendous plant, which was designed to treat 1,000 tons of greensand daily, the process was proved by the operation of a pilot plant treating 10 tons daily. Even this represented an investment of $300,000 which was considered well spent since otherwise it would have been impossible to design the large plant. What then was the cause of the failure? It appears to have been

three-fold. The plant really failed on account of financial mismanagement, according to the word of one who was close to the organization. But shortly after the plant was ready for operation there occurred a tremendous drop in the price of potash; this alone was sufficient to put out of business a multitude of other plants scattered throughout the country which had been established during the war to recover potash from a wide variety of sources. Even so, it is possible that the process was feasible economically at the prevailing relatively low price of potash, provided (and here is the trouble) a market could be found for the byproduct. Without a sizable return from the large volume of insoluble residue there could be no hope for the operation.

The Tail Swung the Cat

Some of the preliminary work done at the pilot plant indicated that those responsible had an idea that the byproduct would be useful, but apparently no one realized that it was the tail that would swing the cat. It was shown that the excess lime and silicates in the residue were capable of reacting with the silica of ordinary sand to form a variety of ceramic products. In fact, bricks from the experimental plant were used in building the Raritan River plant, and other products such as stucco and various molded forms were made which it was thought would have a good market in the New York and Philadelphia districts. The residue itself, containing 50 per cent lime and considerable silica in a very finely divided state, might be used in the fertilizer industry. But the size of the problem of disposing of this material is shown when it is calculated that if running at capacity the plant would have produced enough residue to make 500,000 bricks daily —enough to build a good-sized apartment house.

Regenerating Leather Scrap

New Brunswick, N. J., was also the setting for another example of misdirected energy and capital. A beautiful plant, representing an expenditure of at least $2,000,000, was erected to carry out an Italian process for regenerating leather from scrap. Leather scrap was ground, dispersed in a nitrocellulose solution, then cast on a wheel or belt. The business failed primarily because a proper market study had not been made in advance of manufacturing. Such a study would have disclosed that the product, while technically acceptable, was no better for most purposes than many types of coated fabric or artificial leather already on the market which were much cheaper than the new product.

An interesting sidelight here is that this beautiful plant, after standing idle for several years, was purchased for use in the manufacture of a paint pigment. After the buyer had taken rights on the property and was beginning to plan the remodeling, it was discovered that the water supply was totally inadequate. Also there was no place to install the required waste disposal system in that particular location.

In the 1920's a manufacturer of electrolytic sodium chlorate in Michigan kept going deeper and deeper into the red trying to make potassium chlorate, using as his raw material potasium chloride imported from Germany. His cell capacity was greater than his market for sodium chlorate and it seemed a good idea to keep the plant busy making the corresponding potash salt. But the German potassium chloride contained a rather high percentage of sodium chloride, which complicated the electrolysis by continuously building up in concentration in the cell liquor. A competitor in Niagara Falls, making the same products from the same raw materials, was making a nice profit. Obvious advantages of the eastern manufacturer were lower freight rate on potassium chloride and lower cost for electricity. But these alone were not responsible for the wide difference in financial results. The Michigan people were overlooking a simple bit of physical chemistry which was paying their competitor dividends. The New York plant was kept in continuous operation making sodium chlorate in the cells; the potash salts never got near the cell house. Potassium chlorate was made by double decompostion of potassum chloride with sodium chlorate, under proper conditions of concentration and temperature, in which the presence of sodium chloride in the crude potassium chloride was of course not detrimental. Just a little item, but it made all the difference between success and failure.

Is there a lesson to be drawn from these family skeletons? Possibly we will find it in a conversation reported in an unpublished speech by the Editor of this journal. The head of one of the largest companies in this country was quoted as making the rather surprising statement that he felt the chemical industry was in danger of being "over-engineered." In his company technical men had been promoted to positions of high executive responsibility only to have them make costly errors because they allowed their enthusiasm for technical advance to overbalance their business judgement.

More Economic Training Needed?

If that situation existed generally throughout our industry it would indeed be a severe indictment of the chemical engineer. It is not probable that it does. But the fact that there are quite a few conspicuous failures emphasizes the need for better economic training for our chemists and chemical engineers. By this is meant not merely the formal economics of the economist—important as this is for the foundation. It must be carried farther in the form of chemical engineering economics—the study of the feasibility of processes and the economic valuation of equipment. Nor should it stop here, for equally important is chemical economics—the study of products and materials, sources of supply, markets and marketing methods, and of course prices and price trends. It is probably true that of all of the technical men engaged in research today nine out of ten are studying new or improved products and processes, while only one is studying new markets and uses. From the standpoint of industry's actual needs, the proportion might very well be just the reverse. Better and more profitable distribution through sales development and economic and commercial research is a crying want. There is an almost limitless need for chemical engineers who are also chemical engineering economists.

Acknowledgments

The author wishes to express his appreciation of the assistance given him in gathering the information here presented by L. J. Kenyon of the *Paper Trade Journal*, H. O. Adams, editor of the *Paper Trade Review*, Miss Cora Emery, librarian for Arthur D. Little, Inc., Francis M. Turner, Reinhold Publishing Co., E. M. Flaherty, E. I du Pont de Nemours & Co., Dr. R. Norris Shreve, Purdue University, and R. S. McBride and S. D. Kirkpatrick of *Chemical & Metallurgical Engineering*.

Employers' Views on Education

Professor Bray consulted over one hundred industrial executives regarding chemical and metallurgical engineering education and found them unanimously in favor of confining undergraduate instruction to the fundamentals, leaving specialization to the graduate student

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Chemical engineering, although the youngest of the engineering professions, has experienced in this country a remarkable and continuous increase in enrollment during the past ten years. Purdue University has been no exception, with the result that an expansion in physical plant became necessary if this increasing number of students was to be taken care of adequately. Since the expansion proposed by the president of the university and the board of trustees, represented an expenditure of over $600,000, it became the responsibility of the writer to justify such an expenditure. As a result 112 executives of over 50 large chemical and metallurgical companies were consulted regarding (a) the wisdom of such an expansion, (b) the outlets for the growing number of graduates in chemical engineering, (c) the curriculum which, in their minds, would best fit these graduates for a successful career in industry.

Companies were chosen from the industry at large to give as accurate a cross section as possible, but since a large number of them were employers of Purdue graduates the opinions of the executives were for our purposes particularly significant and valuable. Other members of the profession have found the results of these conferences enlightening and have urged publication of them, feeling that they do represent a trend in engineering education.

Executives were unanimously in favor of the universities confining themselves, at least in a four-year undergraduate course, to instruction in the fundamentals of mathematics, physics, chemistry, English and engineering. Such have been the advances in the science of chemistry alone in the past decade that it has become increasingly difficult to offer adequate instruction in the fundamentals of this science in the ordinary four-year course. As a matter of fact 25 years ago a few pages served to cover what we knew of colloidal chemistry, while now volumes are being written each year about this important subject. Furthermore, if the educational institutions were offering adequate instruction ten years ago, they are obviously no longer doing so if only the same amount of time is devoted to undergraduate chemistry. Since the same line of reasoning holds true, to a somewhat less extent in the other subjects, it is obvious that more time must be found for the fundamentals and it can be only at the expense of the special or vocational subjects.

They were also unanimous in pointing out that a fundamental weakness of the present day engineering graduate is the use of the English language. Whether because of the increasing use of the radio in the home at the expense of good reading on the part of young people; or the greater attention in the elementary schools to such subjects as automobile repairing, welding and broadcasting technique, or the failure of the new methods of teaching elementary English, it is a fact that the present-day engineering graduate emerges from college woefully incapable of expressing himself. Almost without exception the employers pointed out that not only is this graduate unable to express himself in the form of a concise, logical and even correctly spelled report, but what is more important to the graduate himself, indicate that such a deficiency constitutes a serious hazard in his subsequent career. Companies have become so large that the happiness, advancement and material reward for the young graduate lie not with his immediate superior, but in the hands of an executive who judges ability only through the medium of the written word and this in the form of reports. Superior technical or theoretical knowledge only in part make up for a deficiency in the use of English.

It is becoming increasingly evident that the ills besetting us in this day and age are economic rather than technological. The mending of our social and political fences is much more important than building better automobiles, radios or refrigerators. Of the men interviewed, 91 per cent favor liberalization of the engineering curricula. While a recent survey of the E.C.P.D. indicated that engineering graduates are well represented in executive positions the problems these men are to solve are far different than those confronting a similar executive a decade ago. We have come to realize that handling men is far more important than handling money and that in turn than handling materials. Only by learning how men have lived and erred can we approve our own lives.

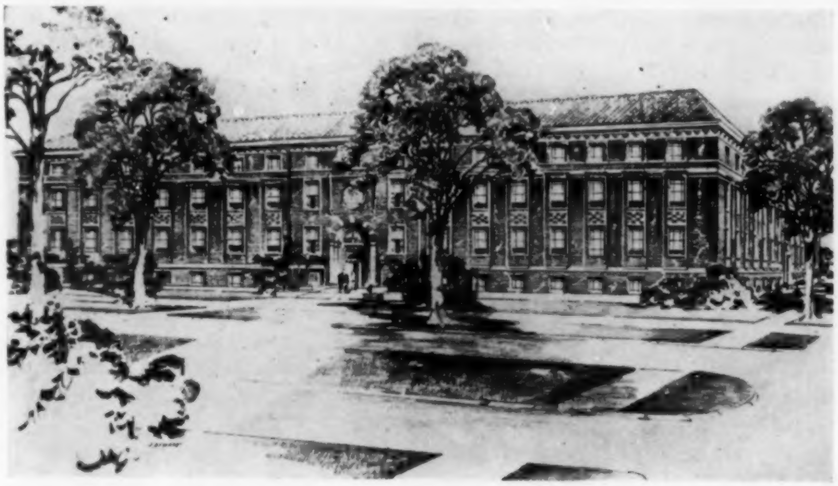
Nearly all executives (87 per cent) were definitely against any form of specialization in the instruction of the undergraduate years. The time available in these four years is all too short and the undergraduate, because of his unfamiliarity with industry, entirely unwarranted in making an early choice of a career. Courses in petroleum technology, ceramics, paper and pulp, organic technology, etc., except in certain

highly specialized districts, should not be offered in the four-year course. If the universities can supply the fundamentals in the time referred to, they will have completed a satisfactory task. Furthermore, the average undergraduate is not at all certain of being able to enter the particular process industry in question, and even if the opportunity should present itself, he is still less certain of being happy and contented in that line of endeavor. The proper place for specialization is in the graduate years.

While not strictly vocational, 84 per cent of the employers seem to regard as such many courses in petroleum technology, paper and pulp, paint and varnish, and organic technology. All too frequently they consist of detailed instruction in the construction and operation of equipment and of processes peculiar to certain industries and not in the theoretical aspects. They were firm in their belief that the universities should use a filter press or a still, for example, only as a means of illustrating certain fundamental laws. The university should not attempt to turn out graduates capable of operating such equipment, for that skill can be acquired sooner and at less expense in the initial few months in industry. These graduates, however, should be familiar with the basic principles involved in the use of such equipment. Furthermore, it was pointed out that advance is so rapid and change so drastic that undergraduate instruction in the use of equipment is largely wasted effort.

The four-year course is evidently inadequate for 92 per cent of the employers. Most of them, however, were against requiring five years for the bachelor's degree in either chemical or metallurgical engineering. Not only would these curricula be out of line with other engineering curricula, but these executives believed that another year of instruction for the average engineering graduate is not worth while. His training is sufficiently broad in most cases to fit him for hundreds of routine and fairly well paying positions in which he will be happy. Only a small part of the graduates, certainly less than 30 per cent, should go on to the master's degree, and still less, probably under 10 per cent to the doctorate, for only they have the superior mentality warranting such an extra investment (as the demand for this instruction grows the universities are learning that it is a pretty expensive form of instruction).

Apropos of the length of the course it is interesting to note that many of the employers of their own volition, and 76 per cent on questioning, maintain that a change must come in engineering education, permitting a more efficient use of equipment and staff. Purdue University made a change two years ago in transferring all instruction and laboratory practice in unit operations to a required summer school of nine weeks. At that time this step was characterized as academic suicide. It has proved to be quite the reverse for our enrollment is greater than ever and the students themselves enthusiastic about this type of instruction which permits much closer correlation between lectures and laboratory and a far more efficient use of the time than is possible in the widely scattered and short class periods during the winter session. Furthermore, as technical education expands, there will come a time when taxpayers object to the shutting down of such an expensive plant as represented by a state university during the summer.



Purdue University's new building for the School of Chemical and Metallurgical Engineering

We recognize as one of our most pressing problems the entrance into the engineering courses of large numbers of young men. Eighty-six per cent of the employers referred to also regard it as such for they point out that a larger and larger percentage of the engineering graduates who come to them are unfitted for engineering employment. Either through the misguided efforts of a high school teacher or through the desire on the part of parents to place their offspring in a white collar position, more and more boys are endeavoring to enter engineering. All too often and frequently too late, we learn that the boy is not temperamentally or mentally suited to follow engineering. Like Eddie Cantor they have "only a sunny disposition and a wild desire to succeed." A great many employers believe that state institutions should require examinations for entrance into the engineering courses. We cannot and are not warranted in expanding to meet this present flood of engineering incompetence.

The executives were all optimistic regarding the future of chemical and metallurgical engineering and the certainty of the demand for graduates in these lines. While they did feel that there will be an increased demand for men with this type of training, it will be only for those who do have the requisite interest and ability. There is such a thing as an engineering frame of mind—not that it is better, but different from others. Because a well-planned course should be broader than other engineering courses, because of the increasing use of chemistry in every phase of industry, because of our growing dependence on chemistry in making up deficiencies and creating new and better products, industry will need more and more young men properly trained along the lines indicated above.

Du Pont's Industrial Relations

What it costs our largest chemical company to maintain its comprehensive program of employee relations, how it works for mutual benefit in stimulating loyalty and cooperation.

E. I. DUPONT DE NEMOURS & Co. is not only the largest of the highly diversified chemical companies of the United States, but in many ways is the most advanced in its dealings with employees. The entire chemical industry looks with unusual interest, therefore, on the annual reports of its president, Lammot duPont, and particularly in those sections that deal with company plans, policies and expenditures for what are called, for lack of a better name, "Industrial Relations." These reports are intended primarily for more than 76,000 stockholders, but as Mr. du Pont has pointed out on another occasion, "The three groups—employees, public and stockholders—cannot be rated in any particular order of importance. All are essential and rank equally. Like a three-legged stool, the structure falls if any one leg is removed."

DuPont's 1938 report, which appeared earlier this month, contains the usual wealth of interesting facts and figures on the company's industrial relations program. At the close of the year, aproximately 47,000 employees, including about 2,300 engaged in construction work, were on the payroll. The average for the entire year was about 47,400—a decrease of ten per cent from the 1937 average. Total wages paid by the company and its controlled subsidiaries was approximately $90,700,000, which was about 16 per cent less than in the preceding year.

In addition to wages and salaries for time actually worked, the company makes substantial expenditures for the welfare of its employees. In 1938 approximately $11,000,000 was expended for protection against financial loss, sickness and accidents, pensions, life insurance, vacations, measures for industrial health and safety. This sum is in addition to taxes, aggregating $735,000, for old age benefits under the Social Security Act; taxes aggregating $2,596,000 for unemployment benefit under various state and federal statutes; and statutory compensation aggregating $319,000 for occupational accidents and injuries. Thus the total expenditures in 1938 under this general head were approximately $14,650,000 or about 18 per cent of the total wages and salaries paid.

A feature of special interest is the Disability Wage Plan, adopted June 15, 1937, which provides, after a two-day waiting period, payment of full wages to wage-roll employees having one or more years of continuous service, during periods of non-occupational illness or injury up to a maximum of three months for any one disability. An older "Benefit Plan" which has been operating for 30 years, was modified May 19, 1937, in order to provide employees having one or more years of continuous service, additional benefits for disability due to *occupational* illness or injury, comparable to that afforded by the Disability Wage Plan for non-occupational illness or injury. Under these two plans 8,338 wage-roll employees received payment of approximately $800,000. Similar protection extended to salaried employees cost $425,000 in 1938.

In addition, the company encourages participation in a contributory Group Accident and Health Insurance Plan, the cost of which is shared with the employee. In 1938, 7,708 received benefits of aproximately $503,000 for disabilities averaging about thirty days. The average payment was $65.25 for each disability. At the end of the year, 97.8 per cent of all eligible employees were insured under this plan.

The Pension Plan, in effect for 34 years, provided monthly pensions in 1938 to 965 employees who had become unable to work because of physical or mental incapacity after 15 years or more of continuous service. Pensions paid amounted to $625,940.

Vacations. The duPont vacation plan for wage-roll employees provides annual vacations of two weeks with full pay for wage-roll employees having one year or more of continuous service and satisfactory attendance records during the 12 months preceding their vacation. The money equivalent of these vacations in 1938 was approximately $1,700,000 and for vacations to salaried employees, approximately $1,300,000.

Industrial Health. In order to provide for physical examinations and for prompt and efficient first-aid in case of emergency, medical service and fa cilities are maintained at all manufacturing plants and at the general offices in Wilmington. This service is provided at company expense by full-time or part-time physicians, according to the needs of the particular locality. Employees are afforded the opportunity of having periodical examinations made as a check on their general health and to discover possible incipient conditions which may need attention by their personal physicians.

The work of the Haskell Laboratory of Industrial Toxicology, established at the duPont Experimental Station in Wilmington in 1935, is being actively continued, and is believed to be justified by the results obtained. The general aim of this specialized research, now conducted by a staff of 20 persons, is to develop methods of protecting the company's employees in the manufacture, and its customers in the use, of such of its chemical products as may be toxic.

Industrial Safety. For many years the company has conducted an extensive program of safety promotion by improving equipment, employing mechanical guards and protective devices, periodical inspections, enforcement of rules of safe practice, establishment of local employee safety committees, and promotion of special activities to encourage and maintain employee interest in accident prevention. As a measure of duPont's extensive program of safety promotion and accident prevention, it is significant that the frequency rate of major injuries (those resulting in loss of time from work) in the company's operations as a whole in 1938 was 1.4 per million hours worked as compared with 1.9 for 1937. This is very much less than that for the chemical industry as a whole, the frequency rate of which in 1937 was reported by the National Safety Council to be 10.2, while that for all of industry was 13.9.

Water Cooling Tower Fundamentals

Heretofore the literature on water cooling towers has contained little practical information to assist in actual design. This article develops the theory of atmospheric cooling of water, while a second article will present a method of design for atmospheric towers, and a third will deal specifically with forced draft towers.

EDWARD SIMONS

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As every engineer knows, the generation and application of heat are only parts of the problem of heat control, for frequently the ability to remove heat is equally necessary. During many centuries the "stored cold" in ice, in the atmosphere, in natural waters, has been used for this purpose, but today such reservoirs for the dumping of unwanted heat are often insufficient, or unavailable. Since the beginning of the study of air-water vapor mixtures which culminated in the science of air conditioning, it has been evident that nature's own air conditioning processes supply the clue for circumventing some of the deficiencies of natural "cold reservoirs." In the continuous rain cycle by which Nature brings about evaporation, then precipitation of the moisture in the form of rain, lies a method which is now being used to a large extent for cooling water to temperatures considerably below that of the air which does the cooling.

That this is being done is no news, nor is it news that the cooling is accomplished by the evaporation of water to the adjacent unsaturated air. The principles of water cooling towers are of some interest, however, as are the forms which this equipment takes.

Cooling Tower Types

Essentially, a water-cooling tower is an apparatus in which the temperature of circulated water approaches the wet-bulb temperature of circulated air during the heat interaction that occurs between the air and the water. This type of apparatus is used primarily to cool recirculated water. However, it should be noted that if the temperature at which water enters a cooling tower is below the wet-bulb temperature, the water will be heated; that is, the approach to the wet-bulb temperature will be along an increasing temperature path instead of the decreasing temperature path which is followed during a water-cooling process.

Although water surfaces of cooling towers are developed in several manners, each type of surface is found in the rain cycle. Rain falls through the air in drop form; water which has fallen as rain appears on the surface of the earth in sheet form. The heat-interchange surfaces of cooling towers are either drop surfaces or sheet surfaces. Furthermore, there are types of towers in which a combination of both surfaces is in action.

The heat exchange in spray towers occurs through surfaces of tiny drops which are formed by the action of nozzles and similar devices. The instantaneous sum of the surfaces of all of the drops is the instantaneous surface area of the tower. The water is generally sprayed from a height in the tower and cooled during the fall to the collecting basin. Spray ponds, which are sometimes used for water cooling, may be described as low and extensive cooling towers. There are also cooling towers in which surface is developed by allowing the water to flow over guiding surfaces. The water spreads over the guiding surfaces and a water-film surface results.

Water surface may be generated by the use of horizontal decks of screen which are placed one above the other. The water is "sliced" into small drop form by the wires of the screening. Furthermore, portions of the surfaces of the cylindrical wires are coated with water film. When screen is used in which the mesh openings are small, the water forms film surfaces in some of the screen openings.

In the deck-type tower, the water is spread over horizontal slatted decks. The deck slats are spaced so that water can pass by gravity from the top of the tower to the bottom. As the water strikes a deck, it spreads over the surface of a slat, flows to cover the underside of the slat, falls in drop or steam form to the next deck where it strikes and splashes into a spray, then follows into the surface which covers the slat. In this type of tower, the slats and structural members provide for the formation of fixed sheet surface. The drops which are formed in falling and splashing provide drop surfaces.

Towers which operate by means of mechanical draft are often designed with very compact slat arrangements. The surfaces of such towers are known as packing or filling.

Cooling Tower Theory

Before we launch into a discussion of the theory of water cooling towers, a few words of review may be in order. The dew-point temperature of air is the temperature at which a given mixture of air and its associated water vapor is saturated with the water vapor. The dry-bulb temperature is the temperature of the air and its associated water vapor as measured by an ordinary thermometer. Finally,

the wet-bulb temperature, which will be explained in detail below, is the temperature which is reached under certain conditions by a wetted wick in contact with air and its associated water vapor. Whenever the air is saturated, the dew-point, wet-bulb and dry-bulb temperatures are identical. When the air is less than saturated, the wet-bulb temperature is below the dry-bulb; and the dew-point temperature is below the wet-bulb. As will be shown, since the rate of heat interchange between water and a water-air mixture in contact with it, is zero only when the water temperature is equal to the wet-bulb temperature of the air, water exposed to air may be cooled *below the temperature of the air*. Hence the wet-bulb temperature (properly determined as will be explained) is the lowest temperature to which water can be cooled by exposure to air.

Nomenclature

Q = Instantaneous rate of heat transfer
h = Coefficient of heat transfer through gas film on surface of drop
A = Surface area of drop
t_a = Air temperature (also air temperature at start of evaporative process)
t_c = Temperature of water drop
W = Instantaneous weight rate of evaporation of water
k = Coefficient of diffusion through gas film on surface of drop
p_c = Pressure of aqueous vapor at temperature t_c.
p_a = Pressure of aqueous vapor in air
r_c = Latent heat of vaporization at temperature t_c
t_w = Water temperature when t_c is at equilibrium temperature
r_w = Latent heat of vaporization at t_w
p_w = Pressure of aqueous vapor at t_w
H_a = Weight of water vapor associated with unit weight of dry air at t_a
H_w = Weight of water vapor associated with unit weight of dry air at t_w
s_a = Specific humid heat of air and associated water vapor at t_a
B = Total pressure of air and associated water vapor, i.e., barometer
M_L = Molecular weight of water vapor
M_A = Molecular weight of dry air
Z = Virtual constant, $= h/r_w k$
R = Instantaneous rate of cooling of water
K = Complex coefficient, virtually a constant, $= r_w k = h/Z$

An examination of a portion of the rain cycle will give an indication of the principles governing this phenomenon. For purposes of analysis, the following conditions will be established:

1. A drop of water of surface area A is exposed to air.
2. The temperature of the water is above the dew point temperature of the air.
3. The dry bulb temperature of the air is above the temperature of the water.
4. The air supply is infinite and the velocity of the air flow along the gas film on the surface of the drop is such that any change in humidity or temperature of the air is negligible.
5. There is no interchange of heat with the surroundings; i.e., the heat exchange process that occurs between the drop of water and the passing air is adiabatic.

Since the air is warmer than the water, there is a flow of sensible heat from the air to the drop of water. This heat flow is expressed mathematically by the equation:

$$Q = hA\,(t_a - t_c) \tag{1}$$

in which the terms are as defined in the adjoining table of nomenclature.

While heat is flowing from the air to the water, there is a diffusive system operating through the interaction of the air and the water. Water passes into the air through the gas film on the surface of the drop. This mass transfer of water is the process of evaporation, and the action may be expressed by the equation:

$$W = kA\,(p_c - p_a) \tag{2}$$

If each side of Equation (2) is multiplied by r_c, the latent heat of vaporization at temperature t_c, the resulting equation will indicate the heat transferred by evaporation, namely,

$$r_cW = r_ckA\,(p_c - p_a) \tag{3}$$

When the rate of inflow of sensible heat exactly balances the rate of surrender of the latent heat of vaporization, a condition of dynamic equilibrium is established; that is,

$$hA\,(t_a - t_c) = r_ckA\,(p_c - p_a) \tag{4}$$

or, substituting specific terms corresponding to the temperature of dynamic equilibrium in Equation (4),

$$h\,(t_a - t_w) = r_wk(p_w - p_a) \tag{5}$$

and

$$(h/r_wk)\,(t_a - t_w) = (p_w - p_a) \tag{6}$$

If the surface of the bulb of a thermometer is kept wetted by the water held in an efficient wick which covers the bulb, and if the air is passed over the bulb *at an appropriate velocity*, the thermometer will indicate the temperature of dynamic equilibrium, t_w. In the early development of psychrometry the association of the ideas of the wetted bulb apparatus and the temperature indicated by the apparatus led to the use of the term "wet-bulb temperature" to identify the temperature t_w. For many years it was believed that this "wet-bulb temperature" was identical with what is called the "temperature of adiabatic saturation," but more recent investigations have shown that these temperatures are equal only at the proper air velocity. Because heat from the surroundings is transferred to the wetted bulb, the process is not strictly adiabatic whereas, in the consideration of the exposed drop it was postulated that adiabatic conditions exist and that the dynamic equilibrium attained is actually the temperature of adiabatic saturation. As noted above, however, it is possible to obtain a true reading of the temperature of adiabatic saturation by observation of a wet-bulb thermometer when the proper air velocity is used. For any given condition of the air and for each size and shape of thermometer bulb used in that air, there is a velocity of the air over the wetted bulb at which the indicated wet-bulb temperature exactly equals the temperature of adiabatic saturation.[1] This velocity may be termed the "velocity of equality."

Although a cooling tower is subject to radiation, the effect of heat interchange with the surroundings is slight and for purposes of analysis one may safely consider cooling tower action to be an adiabatic exchange of heat between air and water. Furthermore, as is stated by W. H. Carrier and C. O. Mackey,[2] " . . . except for exact research work, the error in substituting the adiabatic saturation temperature for the observed wet-bulb temperature is negligible, being, generally, a smaller error than that probable in commercial thermometry." The amount of the small error so introduced will vary with the approach to the velocity of equality, the reading being slightly less than the temperature of adiabatic saturation when the velocity of the air is greater

than the velocity of equality, and slightly greater when the reverse condition holds.

Equation (6) was developed during the consideration of the exposure of a drop of water to an infinite air supply. Now, let an apparatus be assumed as follows:

1. Air flows steadily through an ideally insulated inclosure.
2. The air is brought into contact with a water surface of infinite extent.
3. Water is supplied to the surface at the temperature of adiabatic saturation t_w.

Since the feed water is supplied at the temperature of ultimate dynamic equilibrium, and since heat flows from the air to the water, the air will ultimately be cooled to the temperature of the water. The heat which is given up by the dry air and associated water vapor while cooling to the adiabatic-saturation temperature acts to produce evaporation of water at the temperature t_w. W. H. Carrier[3] has shown that the following statement is true for a mixture of dry air and water vapor: The summation of the sensible heat in the dry air above a base temperature of 0 deg. F., plus the latent heat contained in the water vapor at the saturation temperature, plus the sensible heat contained in the water vapor above the saturation temperature as a base, gives a heat quantity which is constant for a constant temperature of adiabatic saturation. Carrier has designated this heat summation by the term "sigma function."

Considering a unit weight of dry air as a basic unit for a heat balance, one may write:

$$(H_w - H_a)\, r_w = s_a\, (t_a - t_w) \qquad (7)$$

The principles of Dalton's law and Avogadro's hypothesis provide the bases for mathematical definition of the humidities H_w and H_a:

$$H_w = \frac{(p_w/B)\, M_L}{(B - p_w)/B\, M_A}$$

$$\text{or } H_w = \frac{p_w M_L}{(B - p_w)\, M_A} \qquad (8)$$

$$\text{Also, } H_a = \frac{p_a M_L}{(B - p_a)\, M_A} \qquad (9)$$

If the values of H_w and H_a shown in Equations (8) and (9) respectively are substituted in Equation (7), the following equation results:

$$\frac{p_w/(B - p_w) - p_a/(B - p_a)}{t_a - t_w} = \frac{s_a M_A}{r_w M_L} \qquad (10)$$

For values of p_w and p_a which are small in comparison with B, Equation (10) may be written as:

$$p_w - p_a = (B - p_w)\,(t_a - t_w)\, \frac{s_a M_A}{r_w M_L} \qquad (11)$$

A substitution of this value of $(p_w - p_a)$ in Equation (6) gives

$$\frac{h}{r_w k} = \left(\frac{s_a M_A}{r_w M_L}\right)(B - p_w) \qquad (12)$$

An investigation of Equation (12) indicates that $h/r_w k$ is substantially constant. For purposes of derivation the value of the constant will be designated by Z.

In the analysis just completed it was assumed that water at a temperature of t_w was used, but, in cooling towers, water which is at a temperature other than t_w is added to the system. If t_c [Equation (4)] is now defined as the temperature of water entering the cooling tower, and if R is the instantaneous rate of cooling,

$$R = r_c kA\, (p_c - p_a) - hA(t_a - t_c) \qquad (13)$$

By designation, $h/kr_w = Z =$ a constant. Therefore, $h = kr_w Z$ and, assuming $r_w = r_c$,

$$R = r_w kA\, (p_c - p_a - Zt_a + Zt_c) \qquad (14)$$

Equation (6) may be rewritten:

$$p_a = p_w - Zt_a + Zt_w \qquad (15)$$

Finally, when the value of p_a in Equation (15) is substituted in Equation (14), with $r_w k = K$,

$$R = KA\, (p_c + Zt_c - p_w - Zt_w) \qquad (16)$$

Equation (16) indicates that the instantaneous rate of cooling of the water in a cooling tower is dependent upon: (*a*) the constant K; (*b*) the area of the water surface which is exposed to the air; (*c*) the difference between the pressure of aqueous vapor at the temperature of the water and the pressure of aqueous vapor at the wet-bulb temperature; and (*d*) the difference between the temperature of the water and the wet-bulb temperature.

The coefficient K is a complex function of a number of variables. For instance, K varies with the velocity of the air; the movement of the water; the shape of the surface[4]; the size of the surface; the arrangement of the surface; the density of the air; the viscosity of the air[5]; temperature; pressure; etc.

However, for a given shape and size of surface, K is principally a function of the air velocity. W. H. Carrier[6] has presented data which indicate that K varies linearly with variation in the velocity. B. H. Coffey and G. A. Horne[7] presented papers in which they gave an experimentally determined value of K which also showed a linear variation with respect to the velocity. The experimental results of the separate investigations agreed closely.

The properties of the sigma function indicate that an increase in the heat content of the air and associated vapor accompanies an increase in the wet-bulb temperature. As water is cooled in air, the wet-bulb temperature of the air is increased. Therefore, as the air quantity is increased, the wet-bulb temperature throughout the apparatus are decreased. Inspection of Equation (16) indicates that the rate of cooling increases as the wet-bulb temperature decreases. Consequently, an increased air flow through a given tower results in an increased rate of cooling owing to both the decreased wet-bulb temperatures and the increased value of K.

At the present writing, the University of California and the American Society of Heating and Ventilating Engineers are conducting a joint research for the purpose of investigating the operation and design of cooling towers. One of the goals of the work is to establish values of coefficients. California engineering societies and manufacturers have made funds and models available. The results of this work should be of great value to industry and the engineering profession.

It is hoped that the outline of the cooling process which has been given will serve as an aid in the specification and selection of equipment. There are a number of reliable cooling tower manufacturers whose towers can be used with every confidence. Great progress has been made in cooling tower engineering during the past few years. Today, we may look forward with justifiable hope to increased efficiency in our rain-cycle designs.

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M

Readers' VIEWS and COMMENTS

More About Western Phosphates

To the Editor of Chem. & Met.:

Sir:—In answer to the question raised in your September issue, "What About Western Phosphates?" the obvious answer is that the present development briefly described by you is of first interest and importance. It is particularly interesting to note that the production has increased over 300 per cent in five years.

The industries described in your article are of a byproduct nature depending upon byproduct sulphuric acid. During the past ten years I have made a study of the possibilities of production of concentrated fertilizers as primary products at Green River, Wyoming. This work has been referred to in the following publications by the writer in *Ind. & Eng. Chem. 22* 344 (1930); *25* 256 (1933); *25* 374 (1933); R. I. 3190 of United States Bureau of Mines, 1932, Economics of Potash Recovery from Wyomingite and Alumite by Thoenen; Bull. 543 United States Department of Agriculture, Blast Furnace Processes for the Production of Phosphatic and Potassic Fertilizer Materials by Royster et al.

Briefly, the conclusion of this work points to the commercial possibility of producing a potash bearing phosphoric acid in a blast furnace at Green River. The phosphate rock would be shipped from Idaho, and the potash would be derived at no additional cost from the furnace flux of wyomingite, a leucitic potash bearing mineral containing about 11 per cent K_2O shipped to Green River from a nearby quarry. This potash bearing acid could be neutralized with phosphate rock forming a potash triple superphosphate containing about 48 per cent P_2O_5 and about 12 per cent K_2O. A close analogy is noted here to the 48-11 ammonium phosphate produced at Trail, which is mentioned in your article.

The leucitic content of wyomingite is unique among potassium silicate minerals in being amenable to base exchange with sodium. The writer has proposed a process utilizing this property for manufacture of potassium carbonate by base exchange between the Green River soda brine (sodium carbonate) and wyomingite. The potash-bearing phosphoric acid may be neutralized with the potassium carbonate yielding monopotassium phosphate which may be converted to potassium metaphosphate by gentle heating. This latter compound would contain 92-95 per cent P_2O_5-K_2O all of which, though water insoluble, is, according to tests of the Department of Agriculture, available plant food. Or the potassium carbonate may be converted to potassium sulphate by neutralization with sulphuric acid, which is potentially cheap at Green River.

A preliminary unpublished economic analysis recently made by me shows the possibility of profitable large scale development at Green River and does, I believe, justify further intensive study of this proposal on the part of those who are equipped for the development of large scale chemical engineering enterprises. This conclusion is based in part upon an anticipation of steady growth in demand for fertilizer in regions of the United States which are in reality "close" to Green River when considering the shipment of the more highly concentrated fertilizer compounds; which anticipation is based upon information received from authoritative sources.

ROBT. D. PIKE

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LOWER MINING COSTS

To the Editor of Chem. & Met.:

Sir:—May I suggest a correction to the very interesting editorial in your September issue, "What About Western Phosphates?", in which you state that most impartial observers feel that mining costs at western deposits from \$2.50 to \$3 per ton would appear more probable than costs as low as 25¢ per ton noted in some of the more optimistic reports.

We know your statement is true with respect to most western deposits if large tonnage is to be considered; but, at the deposit just north of Vernal, Utah, some 200,000,000 long tons of phosphate rock can without question be mined and delivered to bins at a suitable plant site on the deposit at a cost of not more than 25¢ per short ton.

This low mining cost is possible because this deposit is a nearly horizontal bed about 22 ft. thick, being free from the complex crumplings, foldings and faults characteristic of practically all of the western phosphate deposits, and overburden has been removed from large areas along the sides of canons and draws.

JUDSON S. HUBBARD

Vice President
Humphreys Phosphate Co.
Denver, Colo.

DYNAMIC PRICING

(Continued from page 68)

pany has perfected a transparent, moisture-proof wrapping material during the years just preceding the collapse of 1929. Developmental work and equipment of plants capable of turning out the product in volume had involved heavy expenditures. Comparatively, this new type of packaging was expensive and it appeared that the line might be very unprofitable during a depression period. Further research, this time along distribution lines, showed a definite usefulness of this material in improving appearance and sales appeal of goods packaged in it. The investment in producing the commodity was accordingly increased steadily from an index of 100 in 1928 to 944 in 1937. Sales volume at the same time rose 19.5 times. This large volume, and further perfection of processes, reduced cost per pound in 1937 to less than half what it had been in 1928. Under the dynamic price policy of the company, however, the selling price per pound was reduced even more than costs, so that net profit per pound dropped from an index of 100 in 1928 to 20 in 1937. Under this policy, sales volume rose, as we have seen, and the index of total net profit rose from 100 in 1928 to 400 in 1937. Here we have nearly twenty times as wide use of a product made possible through technological and other improvements passed on through costs reduced more than half, resulting in a net profit to the producer which is four times as great as that realized at the outset.

Machinery, Materials and Products

Improved Electric Valve

A DEPARTURE from conventional design of solenoid valves is found in the new electrically-operated valve recently announced by McDonnell & Miller, Wrigley Bldg., Chicago,, Ill. The new design, developed to insure tight closure against water and other fluid pressure up to 150 lb. per sq.in., employs a spring-loaded leverage system for tight closing. A long lever connected to the armature of the solenoid gives sufficient mechanical advantage for positive opening. Valve and seat are of stainless steel and packing is eliminated by use of a bellows. A built-in strainer is provided for protection of the valve. The valve capacity is from 1,100 to 3,200 lb. of water per hour. The makers recommend it for any fluid not corrosive to its working parts.

Air-Cooled Flock Cutter

AN IMPROVED air-cooled knife cutter for flocking cotton, lint, rayon, wool, silk, asbestos, leather, alpha cellulose and other chemical pulps, has been announced by Sprout, Waldron & Co., Muncy, Pa. The new unit features adjustable Timken bearings, a solid rotor and hinged sides. A special knife arrangement is said to result in the production of little heat. Air flow through the machine accomplishes cooling at the same time it accelerates movement of the material through the unit. Ease of cleaning for switching to different colors and materials is an added feature. A high degree of rigidity, coupled with smooth, vibrationless operation, is claimed.

Portable Filter Press

FOR THE FILTRATION of corrosive chemical solutions which are injurious to, or are contaminated by, metals, T. Shriver & Co., Harrison, N. J., has developed a new compact filter unit, the operating mechanism of which is made of semi-hard rubber. The unit illustrated is a six-chamber filter with a total filtering area of 5.5 sq.ft. and a conservative capacity of 135 g.p.h. Capacity may be increased by adding plates and frames. Any desired filter fabric may be used, and to facilitate cleaning, filter paper may be placed over the cloth. Opening and closing procedures are said to be accomplished in minimum time. The filter is fed with a Shriver duplex diaphragm pump with rubber-lined liquid ends and other rubber parts, powered by a ¼-hp. standard motor. The entire unit is mounted on a portable stand, and is 36 in. high overall.

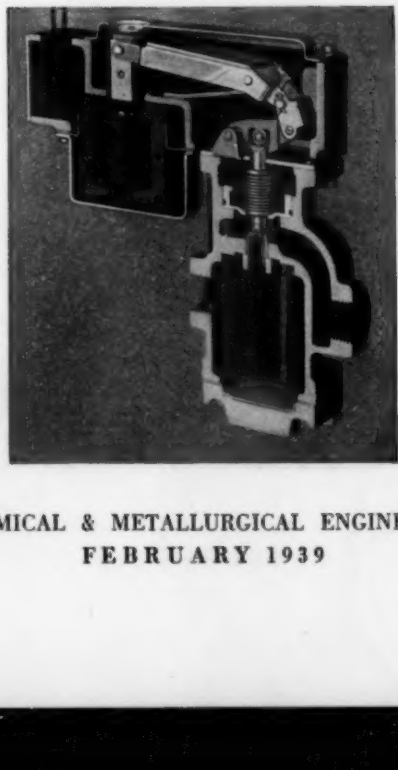
New Products

TWO NEW PRODUCTS recently announced by Glyco Products Co., 148 Lafayette St., New York, N. Y., include flexible shellac and casein. The former is called Flexilac and the latter, Protoflex. Flexilac is an orange colored non-flammable, viscous resin which dries quickly to give a flexible, glossy, adhesive film which is water-soluble, but not affected by hydrocarbons. Suggested uses include gasket cements, insulation, cosmetics, etc. Protoflex is a straw-colored, transparent jelly which dissolves readily in water, the solution drying rapidly to give a flexible, almost colorless, transparent film. Its uses are similar to those of Flexilac.

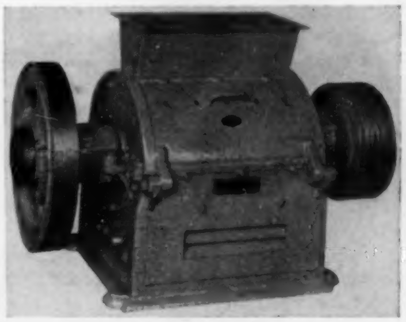
INTRODUCED under the name of Z Nickel, a new alloy developed by the International Nickel Co., 67 Wall St., New York, N. Y., is said to combine the corrosion resistance of nickel with the mechanical properties of heat-treated steel. The strength is said to be from 2½ to 4 times that of ordinary structural carbon steel, although, in the unhardened or annealed condition, the alloy can be fabricated almost as easily as pure nickel. The required heat treatment is at temperatures of 890–930 deg. F. and so produces little heat distortion. Discoloration can be avoided by hardening in a hydrogen atmosphere. Various forms are available commercially, including hot-rolled rods, cold-drawn rods, cold-drawn wire and cold-rolled strips.

REILLY TAR & CHEMICAL CORP., Indianapolis, Ind., has introduced a new paint, "Creocoat", available in green, yellow, red, black and brown, which is stated to form a seal through which neither pitch nor creosote can penetrate. Claimed to be the first successful coating for creosoted wood block flooring, the new paint has been under development for several years. It produces a hard, bright finish which is stated to be highly resistant to abrasion and wear, and im-

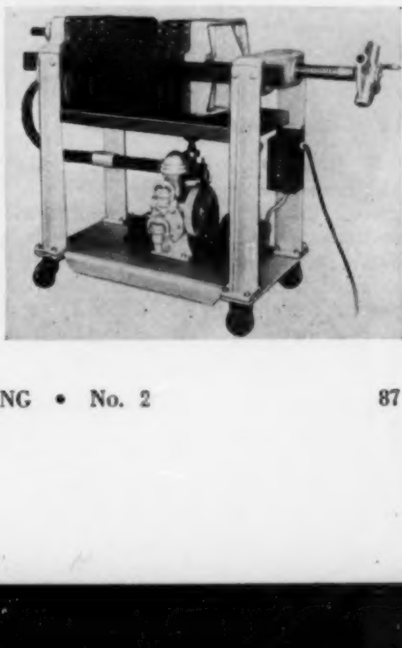
Cross section of new electric valve



Improved flock cutter



Portable rubber-lined filter



pervious to oils and dilute acids. Through its use, creosoted wood block floors are now employed successfully, according to the manufacturer, in places where they were never before suitable.

A NEW CLEANER for use in the porcelain enameling industry, capable of removing most mineral or vegetable oils used in stamping and drawing operations on sheet iron, has been announced by the Porcelain Enamel & Mfg. Co., Baltimore, Md. The new cleaner, which is put up under the company's trademark name of Pemco, is stated to be completely soluble and to contain no free resin or other ingredients which depend on high temperature reactions in the cleaner tank to become effective.

Barrel Discharge Elevator

BARRETT-CRAVENS Co., 3255 West 30th St., Chicago, Ill., has recently developed a new discharge elevator for barrels and drums, designed to pick up such containers and raise them to any desired height for discharging. Liquids, powders and fine granulated materials may thus be fed into hoppers, vats and truck bodies with speed and safety. Such elevators are built in any desired capacity, for any lifting height; or the required special attachments may be applied to both hand and electrically operated elevators of this company's make which are already in service. A special quick-applying harness is used to secure the barrel or drum to the elevator forks. Only a slight tug is necessary to tilt the container when it has been lifted to the proper height.

Glass Fiber Gasket

FOR ACID RESISTANT SEALS in chemical work, the Goetze Gasket & Packing Co., New Brunswick, N. J., has developed a line of woven glass fiber gaskets which are said to be soft, pliable, resilient and resistant to all acids except hydrofluoric. The company is also prepared to supply packings of this same material for use in centrifugal and reciprocating pumps and valve stems.

Another recent development of the Goetze company is a line of renewable disks for globe valves, suitable for any service to which a globe valve can be put. Disks are of laminated construction, built up of alternate layers of asbestos and metal, encased in a two-piece shell of whatever metal or alloy is suitable. Available sizes range from ¼ to 12 in.

pH Comparator

W. H. TAYLOR & Co., 872 Linden Ave., Baltimore, Md., has announced an improved slide comparator for colorimetric determination of pH, chlorine and phosphates The new outfit is entirely moulded from plastic and has been improved in appearance, durability and ease of handling. The entire outfit is only 10 in. long and weighs only 1½ lb. It consists of a slide and base, each slide containing nine color standards, guaranteed to maintain their accuracy for five years. One base serves for all color standard slides. The base holds indicator solutions, pipettes and test tubes.

Improved Motor Trolley

AMERICAN ENGINEERING Co., Philadelphia, Pa., announces the development of a new motor trolley, the Type RB, with which it is possible to obtain a motor-driven trolley Lo-Hed hoist in capacities of 1-3 tons. The motor trolley is a separate unit sold either in combination with this company's class B hoists, or sold separately for converting a variety of hoists not provided with a motor trolley. The new motor trolley features moderate price, short wheel base, low headroom, four-wheel drive, and balance. All wheels are gear-driven, providing maximum tractive effort. Balance is secured by means of an adjustable counterweight. Cut gears and roller bearings are standard equipment.

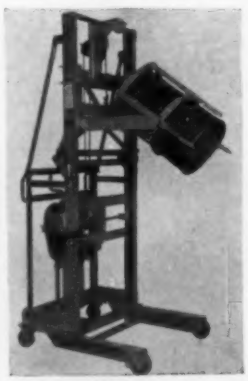
Equipment Briefs

FOR GENERAL industrial eye protection where lightness, wide vision and good ventilation are requisite a new visor type eye shield has been made available by the Jackson Electrode Holder Co., Detroit, Mich. Designated as Type C (Type D is slightly smaller), the new shield consists of a flexible, transparent, nonflammable visor, either clear or in various colors, adjustably hinged to a light headgear. Although it gives protection from both the front and sides, it is said to be comfortable to wear in that no part of it rests on the nose or ears. The shield does not interfer with eye glasses. When not needed it can be raised out of the line of vision.

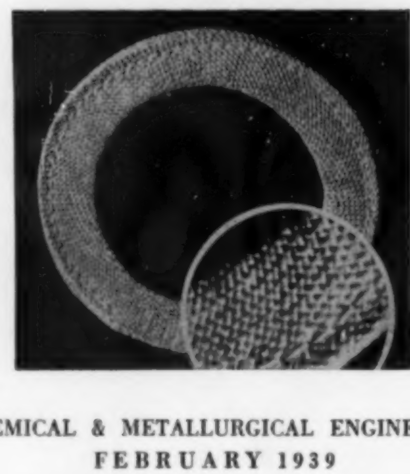
REMOVING MOISTURE from chemical liquids and from air and gases is the function of the new Henry Cartridge Dehydrator recently put on the market by the Henry Valve Co., 1001 North Spaulding Ave., Chicago, Ill. Cartridges are available charged with activated alumina, Drierite, calcium oxide, barium oxide or anhydrous calcium chloride. When exhausted, a refill cartridge is easily installed. A perforated dispersion tube extends along the center axis of the dehydrating cartridge, reducing pressure drop, eliminating channeling and insuring complete use of the dehydrating material. Refill cartridges are sealed in dehydrated air to assure complete dryness until the seal is broken.

FOR CUTTING structural glass to finished dimensions, the Musto-Keenan Co., 1801 South Soto St., Los Angeles, Calif., has developed the Felker Di-Met track machine, a portable unit, consisting of an electrically-driven Felker Di-Met diamond impregnated metal blade which moves on a raised track over the material being cut. Vertical adjustment of the blade allows for deep or shallow cuts. On recent tests, the cutting unit is

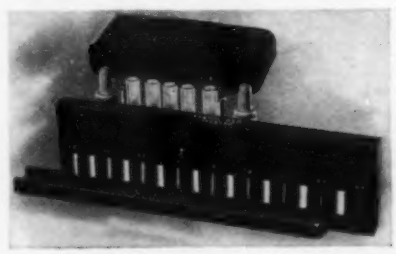
Barrel discharge elevator



New glass fiber gasket



New pH slide comparator



Improved motor trolley for hoists

stated to have operated along an 8-ft. track, permitting a 6-ft. cut on 7/16-in. structural glass, normally cutting 18 in. per minute and, on forced feeding 24 in. per minute.

BUILT PRIMARILY for testing and standardizing service instruments and thermocouples, for exploratory work, and as a spare instrument, the Foxboro Co., Foxboro, Mass., has introduced an improved portable indicating potentiometer pyrometer which is fully protected against damage and readily carried in one hand. An open, legible temperature scale, 17 in. in length, permits readings to close limits. Double-range instruments have two scales, both of which may be for temperature, and for the same or different thermocouples. Calibration in either temperature or millivoltage units may be made. Automatic cold junction compensation is provided by a special compensator coil.

MANUFACTURERS' LATEST PUBLICATIONS

Activated Clays. Filtrol Corp., 315 West 5th St., Los Angeles, Calif.—32-page spiral-bound bulletin on Filtrol products, with particular reference to the use of this company's activated clays in various industrial fields.

Air Conditioning. Carrier Corp., Syracuse, N. Y.—A. I. A. File 30 F 1-2—16-page catalog briefly describing air conditioning, refrigeration and heating equipment for a variety of applications.

Ammonia Leaks. Pennsylvania Salt Mfg. Co., Dept. 11, 1000 Widener Bldg., Philadelphia, Pa.—Card carrying six sulphur tapers for use in testing connections in anhydrous ammonia lines for the purpose of detecting leaks; available to all ammonia users.

Chemicals. American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York City—Leaflet 561—46 pages on this company's Aero Ac 50, a delayed action activator for use with rubber accelerators. Gives complete information on tests with many types of rubber compounds.

Chemicals. Pfaltz & Bauer, Empire State Bldg., New York City—6-page folder describing De Haen's Fixanal preparations for standard solutions.

Coatings. M. W. Kellogg Co., 225 Broadway, New York City—4-page folder describing Thur-Ma-Lox heat resistant coatings for the protection of steel at temperatures to 1,800 deg. F. Describes properties of two grades and lists suggested uses.

Compressors. Sullivan Machinery Co., Michigan City, Ind.—Bulletin A-18—New 16-page catalog describing this company's line of Class WN-112 air and gas compressors, with information on installations and construction.

Controllers. Schaefer Bros. Co., 1059 West 11th St., Chicago, Ill.—12-page catalog on this company's electrical control apparatus, resistors and rheostats with information on prices and dimensions.

Dryers. Link-Belt Co., 300 West Pershing Road, Chicago, Ill.—Book 1711—16 pages describing this company's Roto-Louvre dryer, with particular reference to its use in connection with such materials as coal, ore and chemicals.

Electrical Equipment. Louis Allis Co., Milwaukee, Wis.—Bulletin 515—4-page booklet with two-page chart on motor applications indicating types, sizes of motors, torque characteristics, general characteristics and typical applications. Also Bulletin No. 610, 8 pages of general information on N.E.M.A. standards and definitions.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1195—8 pages describing construction features of this company's squirrel-cage induction motors; also Leaflet 2203-B, 4 pages describing this company's self-contained gearmotors.

Electrical Equipment. Century Electric Co., St. Louis, Mo.—Manual 21-121—4-page leaflet describing the installation, care and adjustment of fractional hp. capacitor single-phase motors.

Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Publications as follows: B. 2175, 44-page book describing in detail this company's Type M general purpose turbine in sizes from 100 to 2,000 hp.; B.2156, 16 pages on the uses of Micarta in the paper industry; DD 3620, 12 pages on Types FH and DH speed reducers; B.2170, 18 pages describing in detail this company's single and multiple retort stokers in sizes from 100 hp., up; DD 3610, 8 pages on gearmotors; B.2131, 8 pages on line starters and circuit breakers; B.2164, 10 pages of simple facts about synchronous motors, written for the layman.

Filters. Cuno Engineering Co., Meriden, Conn.—Case study book of 80 actual cases, showing this company's continuously cleanable filters at work in industry; covers process, power and heavy industries.

Handy Scale. Graver Tank & Mfg. Co., 4815 Tod Ave., East Chicago, Ind.—Plastic pocket scale, giving on one side capacities of vertical tanks per inch and foot of depth in diameters ranging from 6 in. to 100 ft. Reverse side gives temperature conversion scale, volume and weight conversion factors and hydrometer correction table.

Instruments. The Bristol Co., Waterbury, Conn.—Publications as follows: Bulletin 514, 20 pages on this company's air-operated Synchro-valves for automatic control; Bulletin 523, describes single-cam cycle controllers; Bulletin 1452, 36 pages giving complete information on this company's entire line of wide-strip pyrometer recorders and controllers.

Instruments. Burling Instrument Co., 241 Springfield Ave., Newark, N. J.—Leaflet briefly describing this company's "Temperature Dictators," a line of four controllers for temperatures ranging up to 1,400 deg. F.

Instruments. Julien P. Friez & Sons, Baltimore, Md.—Data Sheet 225 and Bulletins TS, LC, TM, CS and CR—Leaflets describing a new line of high voltage room thermostats, oven controls and space thermostats, featuring a solid liquid-filled sensitive system and contacts capable of high capacity without the use of relays.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 202-2—24 pages completely describing this company's potentiometer controllers with information also on special types of controllers and recorders; also Bulletin DMF 765, 4 pages briefly describing this company's potentiometer recorder controllers.

Instruments. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.—Catalog 1170—16 pages completely describing this company's dial indicating thermometers, with list prices.

Laboratory Apparatus. The Emil Greiner Co., 55 Van Dam St. (After Mar. 1, 161 Sixth Ave.), New York City—9th Edition of general catalog on laboratory apparatus and chemicals, including 700 pages composing 22 sections on testing apparatus, laboratory supplies and apparatus, balances, pH apparatus, optical instruments, chemicals, etc.

Linings. Heil & Co., 3088 West 106th St., Cleveland, Ohio—Leaflet briefly describing properties and applications of this company's Plast-O-Line chemical-resisting tank lining material for use at temperatures to 200 deg. F.

Materials Handling. Chain Belt Co., Milwaukee, Wis.—Bulletin 331—16 pages on the handling of coal and ash with this company's equipment; Bulletin 337, 8 pages on the handling of fertilizer materials.

Materials Handling. Elwell-Parker Electric Co., Cleveland, Ohio—Bulletin A-8416—4 pages describing this company's low-lift platform trucks; Bulletin A-8459, 4 pages on high-lift platform trucks.

Materials Handling. Stephens-Adamson Mfg. Co., Aurora, Ill.—Catalog 7738—8-page booklet describing this company's car-pullers, hoists and winches, with dimensions, specifications and descriptive data.

pH Measurement. Paul Frank, 456 Fourth Ave., New York City—4-page leaflet describing pH test papers for use in all aqueous solutions, covering the entire pH range in steps of 0.2 or 0.3 pH.

Proportioners. Proportioneers, Inc., 9 Codding St., Providence, R. I.—Bulletin TOU-3—19-page booklet on the application of this company's proportioners, completely detailing features of various types of feeders, sampling and proportioning equipment.

Pumps. DeLaval Steam Turbine Co., Trenton, N. J.—Catalog L-31—8 pages on this company's IMO oil pump, describing construction, applications and advantages.

Regulators. Foster Engineering Co., 109 Monroe St., Newark, N. J.—Catalog 70, Bulletin 5—12-page booklet on this company's U-type pressure reducing regulators for water and air, as well as other gases and liquids. Gives detailed descriptions of five types of regulator.

Safety Clothing. American Optical Co., Southbridge, Mass.—Bulletin TL-172—28-page catalog covering this company's line of safety clothing, including heat and acid-resisting clothing of asbestos, leather, rubber, rubberized fabrics and other treated fabrics; also protective clothing for various parts of the body, complete suits, helmets, respirators and related products.

Safety Equipment. H. S. Cover, 111 Chippewa St., South Bend, Ind.—Leaflet describing this company's gas-tight, fog-proof rubber goggles, and five types of respirator made by this company.

Valve Reseater. Standard Reseater Corp., 423 West 126th St., New York City—Leaflet describing this company's reseater for the insertion of renewal seats in all makes of seat type valves having seat orifice diameters ranging from ¼ to 1½ in.

Valves. W. S. Rockwell Co., 50 Church St., New York City—Leaflet 387—Briefly describes this company's oil-flow control valves for oil-burning furnaces.

Water Treatment. D. W. Haering Co., 3408 West Monroe St., Chicago, Ill.—6-page reprint of an article on film inhibitors in industrial aqueous systems, with reference to the application and control of chrome-glucosate derivatives.

Welding. Arcos Corp., 401 North Broad St., Philadelphia, Pa.—Technical Bulletin 3—Manual on welding of stainless and heat-resisting alloys, nonferrous and special metals.

Chemical Engineering NEWS

Canadian Chemical Convention Scheduled for June

The Twenty-Second Annual Canadian Chemical Convention will be held this year in London, Ontario, June 5-8. T. A. Faust, president of Yocum-Faust, Ltd, is chairman of the local committee, with Dr. J. A. Gunton, of the Department of Chemistry, University of Western Ontario, vice-chairman. A number of committees have been formed and plans for the local arrangements are already well advanced.

Several new features will be incorporated in the program this year. At the general sessions and public lecture, outstanding speakers will be heard and Prof. Otto Maass, F.C.I.C., director of the Department of Chemistry, McGill University, and president of the Canadian Institute of Chemistry, and Dr. R. K. Stratford, director of research, Imperial Oil, Ltd, and president of the Canadian Chemical Ass'n, will deliver presidential addresses.

There will also be meetings of the Industrial and Engineering Section, Pure Chemistry Section, Biochemical and Agricultural Chemistry Section, Food and Cereal Section, Chemical Education Section. A new section, Metallurgy and Mining, will be inaugurated. Special attention is to be given to a discussion of the possibilities of wider and better utilization of agricultural products for chemical and industrial purposes, in line with the recently established Chemurgic Council of the Canadian Chamber of Commerce.

Chemical Alliance Transfers Headquarters to Washington

Chemical Alliance has transferred headquarters from New York to Washington, and has opened offices in the Woodward Building. Announcement to that effect followed the announcement that the Alliance has, at its recent annual meeting, elected three new directors. They are C. S. Munson, of the U. S. Industrial Alcohol Co., H. M. Hooker, of the Hooker Electrochemical Co., and T. P. Walker, of the Commercial Solvents Corp. These new directors will fill vacancies on the board caused by deaths. The board also announced the election of the following officers:—president, Charles Belknap, Monsanto Chemical Co.; vice-presidents, Lammot duPont, of E. I. duPont de Nemours & Co., C. S. Munson, U. S. Industrial Alcohol Co., Willard H. Dow, Dow Chemical Co.; treasurer, J. W. McLaughlin, Carbide & Carbon Chemicals Corp.; secretary, Warren N. Watson, Washington, D. C.

House Bill Proposes Sodium Chlorate Production

Government manufacture and distribution of sodium chlorate to be used for the control of noxious weeds is proposed in a bill (H. R. 196) introduced in the House by Rep. Walter M. Pierce, Oregon. Under the proposed measure the Secretary of Agriculture would be empowered to purchase the needed property and facilities now owned by the government in the vicinity of Bonneville Dam. The measure also would authorize an appropriation of $750,000 for construction and equipment of an electrochemical plant capable of producing from six to eight million pounds of chlorate of soda annually. It also would authorize an operating fund of $250,000 for the fiscal year of 1940 and "a sufficient sum to carry out the purposes of the act" for each fiscal year thereafter. The chlorates produced at the plant would be distributed at cost to cooperating States.

Program Completed for Ninth Packaging Conference

Details of the Ninth Conference on Packaging, Packing and Shipping, to be held concurrently with the Ninth Packaging Exposition, at the Hotel Astor, New York, March 7-10, have been announced by the American Management Association, sponsoring organization for the conference and exposition. The exposition will present the products of some 75 companies. A feature of the exposition will be a showing of all packages entered in competition for the Eighth Irwin D. Wolf Awards for distinctive merit in packaging.

The opening session will be devoted to unit packaging with Alvin E. Dodd, president of American Management Ass'n., as chairman. In the afternoon, Dr. L. V. Burton, editor of *Food Industries* will supervise a symposium on packaging and the new pure food, drug and cosmetic law. On the morning of March 8, D. S. Hopping, director of sales, Celluloid Corp., will have charge of a session on industrial packaging and in the afternoon, a packaging clinic will be conducted by W. F. Deveneau, sales promotion manager of National Folding Box Co. On March 8 a symposium on export shipping will have J. H. Macleod, vice-president, the Hinde & Dauch Paper Co., as chairman.

Temperature Symposium to Be Held in Fall

A symposium on "Temperature and its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics, probably next fall, the dates to be announced later. Consistent with the title, the symposium will broadly cover many fields, its primary purposes according to present plans being to: coordinate the treatment of the subject in the sciences and branches of engineering; review principles and bring up to date the record of recent work; accumulate contributions for a comprehensive text, to be published as soon as possible after the symposium is held; reveal the subject as an important branch of physics; and supply schools with the information required for the improvement of curricula.

A representative committee has been formed consisting of the chairman, C. O. Fairchild, director of research, C. J. Tagliabue Mfg. Co.; Dr. E. F. DuBois, medical director, Russell Sage Institute of Pathology and professor of medicine, Cornell University; Dr. Gustav Egloff, director of research, Universal Oil Products Co.; Dr. John Johnston, director of research, U. S. Steel Corp.; Dr. Walter G. Whitman, department of chemical engineering, Massachusetts Institute of Technology; and Dr. H. A. Barton, director, American Institute of Physics.

Model State Food and Drug Law Drafted

Draft of a model state food, drug and cosmetic law, which approaches closely the Federal statute has had the virtual approval of the executive committee of the Association of Food and Drug Officials of the United States, in session in Washington during the latter part of January. The proposed model law is drafted with provisions similar to the Federal law, and it contains provisions intended to bring the state laws and the regulations under such laws into conformity in the several states with the Federal statute. Representatives of the committee held conferences with Dr. R. L. Fischelis, Trenton, N. J., representing the National Drug Trade Conference, Charles Wesley Dunn, New York, for the food manufacturers and Ole Salthe, who was the technical advisor for the late Senator Copeland in the enactment of the Federal law.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

CONGRESS versus President! This is the headline bout of the politico-sports arena of Washington. Round one was fought over W.P.A. money in January; and the President lost on points. The stake in the battle is control of the Democratic party in 1940. The nominal controversies continue over questions of economy on W.P.A., new reform legislation, politics in relief, and like questions. They are all very much subordinate to party control. This sounds like pure politics, but politics today is a business problem.

Temporarily the President is continuing a sincere effort to appease business so that there need be no further recessions. Another such episode between now and election day, 1940, would be calamitous for many Democrats, particularly for the New Dealers. But a strong undercurrent of reform continues in such matters as resource control, anti-monopoly, patent restrictions, regulation of all kinds of business, particularly manufacturing enterprise. Under these circumstances it seems as though the reformers have been doing pretty well in keeping their most obnoxious tactics in restraint.

Preparedness Studies

In another column is given the text of definitions and lists recently announced by the Army and Navy Munitions Board for those commodities which are strategic, critical, or essential for military planning. A large number of these 72 commodities are of direct concern to chemical process industry. Some of them are products, more of them are raw materials. They all tie in with peace-time manufacturing quite as importantly as with military supply.

The mineral commodities have given special concern lately. Therefore, a new advisory committee has been organized, made up of distinguished educators, industrialists, and government mineral economists. Under this small central group there are being established sub-committees, one for each of the major strategic and critical minerals. It is not unlikely that some of the non-mineral commodities will be similarly treated. Those interested in them may, therefore, properly ask such treatment, if they think that the War and Navy planning is not quite adequate, or not fully up-to-date.

In the case of minerals one of the major objectives is to develop information on which the government may decide about the need for stock piles. Such reserves would be built up at the present time and held in government ownership for military purposes. They would be drawn on only when the President should decide that the imminence of a military emergency required this. It may be that certain of the non-mineral commodities could have such treatment. Incidentally the most favored legislation of this sort provides for all classes of strategic materials, not only minerals. Those of process industry who would like to press this matter should look into the question soon, and aggressively.

TNEC and Process Industry

The early February effort of TNEC has dealt with insurance companies and the problems of institutional investment. That affects process industry indirectly because these big investment enterprises often buy privately the securities of industrial companies. Thus the problems of S.E.C. supervision are minimized, and the reform element of Washington disappointed.

Far more important to chemical engineering will be the series of industry studies on which TNEC will embark later in February, or early in March. No formal decision has been announced at the date of this writing (February 4) as to which industries will first be scrutinized by public hearing, nor as to just how these enterprises will be treated. But Washington understands that at least the following five will have an unwelcome opportunity in the spotlight soon. The probable sequence now forecast is: gypsum, sulphur, petroleum and petroleum refining, steel, natural gas. In all cases the emphasis will be on monopolistic tendencies, but a very broad economic treatment is wanted in addition. It is rather expected that the glass container industry will find some company in its discomforture before this series of investigations and hearings is done. And the list given is far from complete.

Phosphate Report

The report of the committee which was headed by ex-Senator Pope of Idaho was submitted to the Senate through Senator Pepper shortly after the middle of January. Following a general review of the importance of phosphate to agriculture and the problems of domestic consumption and of export, the committee dug into the controversial problem of phosphate reserves and the alleged need for development of western phosphates. It was apparently fully persuaded that America has a far more complete supply than was previously appreciated. But even so, it made several recommendations as to further study and development deemed desirable. In brief these were:

1. Congress should name a committee to study the amount, ownership, and method of utilizing potash, borax, and such other mineral resources of the United States as may appear advisable.
2. U.S.G.S. should be given means for a more thorough study of phosphate and potash reserves, and the interrelation of phosphate and potash in fertilization.
3. Continued activity on experimental and demonstration use of fertilizers by TVA.
4. Continued program of A.A.A. in furnishing concentrated phosphate fertilizers to farmers in lieu of benefit payments.
5. A plant for experimental, educational, and demonstration purposes, using the western phosphate deposits, with temporary preliminary work by TVA.
6. Possible purchase by the government of many Florida phosphate lands.
7. Legislation to protect American process patents. (The Peterson bill would give the same embargo on imports of goods made under a process patent as the tariff law now gives to goods which would infringe a product patent.)

The appointment of Senator Pope to the Board of TVA as successor to A. E. Morgan means that these phosphate recommendations are likely to get very sympathetic development in that agency soon. But it is not evident that Congress is likely to spend any new money on western phosphates.

News "Fines"

Cosmetic Colors—Certified colors for use in cosmetics after next June 24 will be investigated specially by Food and Drug Administration with a new $30,000 fund, if the pending deficiency appropriation bill passes, as recommended by the President. This matter is urgent because after that date no cosmetics may use uncertified colors. There is a conflict between the law on this subject and the Food and Drug Administration regulations which may make delay in enforcement necessary. But Congress can fix that too, if it acts soon.

Alcohol Formulas—During January a complete revision of formulas for denatured alcohol has been issued. Users, as well as producers, can now get these up-to-date regulations in a single cover.

Wage-Hour Rulings—The Fair Labor Standards unit has discovered that the

natural ice industry is a seasonal business, and has granted formal approval to over-time in this and several of the tobacco handling activities of the country. Little progress has been made however on exempting other seasonal activities like fertilizer manufacture, and little is expected soon. About February 1 Commissioner Andrews finally found so culpable a firm as to start an enforcement suit in North Carolina. This is the first court action for enforcement, indicating the very general cooperation of industry and the difficulty of finding any deliberate violations.

Council of Industrial Alcohol Users Formed

At a meeting held at the Chemists' Club, New York, on Jan. 24, a Council of Industrial Alcohol Users was formed with the following officers: chairman, Ernest T. Trigg, president of the National Paint, Varnish, and Lacquer Ass'n; vice-chairman, Carroll Dunham Smith, president of the American Pharmaceutical Mfrs Ass'n; executive secretary, Dr. H. E. Howe, editor of *Industrial and Engineering Chemistry;* treasurer, Rowland Jones, Jr., secretary of the National Drug Trade Conference. An executive committee will be selected, comprising one member from each of the scientific and trade groups represented in the Council.

The organization meeting, which was preceded by a luncheon, was held under the auspices of the Industrial Alcohol Institute with Bruce Puffer, vice-president of the Institute, presiding.

Patent Legislation Looms Before Congress

Patent legislation of large importance to chemical process industry will be considered by Congress shortly. But this is not at all likely to include legislation on the anti-monopoly features of the patent system. The subjects which will get preferred attention soon are those recommended by Commissioner of Patents Conway P. Coe particularly:

1. A single court of patent appeals. A major feature of the controversy on this point will be whether the court should be provided with some special technical experts.

2. The limitation of the life of patents to a period of twenty years from the date of filing, if that date is reached before the end of seventeen years from the date of granting the patent. This is intended to make it impossible to extend the life of a patent by keeping it a long time in the Patent Office unissued.

3. Great curtailment of the interference proceedings in the Patent Office, making the finding of the first examiner of interferences final for the granting of the patent. This would throw into court litigation all further reviews, and would prevent the many appeals now possible.

4. Abolish renewal applications. The purpose would be to prevent holding granted patents in the Office, as is now possible under the renewal procedure.

5. Reduce the period of public use of invention from two years to one year before filing an application for patent.

6. Reduce from two years to one year the time within which an applicant may copy a claim from an issued patent for the purpose of claiming priority.

7. Increase the authority of the Commissioner of Patents to speed up actions while an application is in the Office.

Pressing these seven reforms, mainly to speed up and simplify patent procedure, does not mean any abandonment of the anti-monopoly effort. It means simply that no one has yet figured out just how to phrase effectively the wanted further anti-monopoly law. This question will be studied by TNEC during the rest of this year.

Albert Sauveur Dies in Boston

Albert Sauveur is dead. He died January 26 after a week's illness in Boston, Mass., at 75 years of age. Dr. Sauveur, at the time of his death, was Gordon McKay professor emeritus of metallography and metallurgy at Harvard University, having retired in 1935.

During the World War he was metallurgist for the American Aviation Commission in France and metallurgical adviser to the French Ministry of Munitions. Professor Sauveur was described as "a founder of the science of metallography" in the citation accompanying his honorary degree of doctor of science from Harvard the year he retired.

In 1898, he founded the ***Iron & Steel Magazine*** which eight years later was consolidated with *Electrochemical & Metallurgical Industry*, an early title of *Chemical & Metallurgical Engineering.*

Foreign Fertilizers Banned In Puerto Rico

Ban on purchase of foreign-made fertilizers by Puerto Rico agricultural cooperatives is announced in a statement issued by Harold L. Ickes, Secretary of the Interior and Administrator of Porto Rican reconstruction. This action followed the filing of protests by Porto Rican and mainland fertilizer companies. The protest was against the action of a Puerto Rican cooperative which had purchased 1,600 tons of fertilizer from Germany, out of its annual purchases of 10,000 tons. Secretary Ickes stated that under an agreement with the resident assistant administrator, cooperatives which are financed partly by the Puerto Rican Reconstruction Administration will make no further foreign purchases.

Preparedness Materials Are Defined and Approved

Definitions and lists approved Jan. 7, 1939 by the Army and Navy Munitions Board include:

Strategic Materials (17)—Strategic materials are those materials essential to the national defense for the supply of which in war dependence must be placed in whole, or in part, on sources outside the continental limits of the United States, and for which strict conservation and distribution control measures will be necessary.

Aluminum	Quartz Crystal
Antimony	Quicksilver
Chromium	Quinine
Coconut Shell Char	Rubber
Manganese, ferrograde	Silk
Manila Fiber	Tin
Mica	Tungsten
Nickel	Wool
Optical Glass	

Critical Materials (20)—Critical materials are those materials essential to the national defense, the procurement problems of which in war, while difficult, are less serious than those of strategic materials because they can be either domestically produced or obtained in more adequate quantities or have a lesser degree of essentiality, and for which some degree of conservation and distribution control will be necessary.

Asbestos	Nux Vomica
Cadmium	Opium
Coffee	Phenol
Cork	Picric Acid
Cryolite	Platinum
Flaxseed	Scientific Glass
Fluorspar	Tanning Materials
Graphite	Titanium
Hides	Toluol
Iodine	Vanadium
Kapok	

Essential Materials Neither Strategic nor Critical (35)—In this classification are included those materials, essential to the national defense, for which no procurement problems in war are anticipated, but whose status is such as to require constant surveillance because future developments may necessitate reclassification as strategic or critical.

Acetic Acid	Nitrogen Compounds
Abrasives	Palm Oil
Acetone	Paper and Pulp
Alcohol (Ethyl)	Petroleum
Arsenic	Phosphates
Camphor	Potash
Castor Oil	Refractories
Chlorine	Shellac
Copper	Sisal
Copra	Sugar
Cotton Linters	Sulfuric Acid (Incl. Sulfur and Pyrites)
Helium	Uranium
Hemp	Webbing and Duck
Jute	Wheat
Iron and Steel	Zinc
Magnesium	Zirconium
Methanol	
Molybdenum	

Current PRICES

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.05½-$0.06½	$0.05½-$0.06½	$0.05½-$0.06½
Acid, acetic, 28%, bbl., cwt	2.23 - 2.48	2.23 - 2.48	2.23 - 2.48
Glacial 99%, drums	8.43 - 8.68	8.43 - 8.68	8.43 - 8.68
U. S. P. reagent	10.25 -10.50	10.25 -10.50	10.25 -10.50
Boric, bbl., ton	106.00-111.00	106.00-111.00	105.00-115.00
Citric, kegs, lb	.22½- .25	.23½- .25	.24 - .27
Formic, bbl., ton	.10½- .11	.10½- .11	.10½- .11
Gallic, tech., bbl., lb	.70 - .75	.70 - .75	.75 - .78
Hydrofluoric 30% carb., lb	.07 - .07½	.07 - .07½	.07 - .07½
Lactic, 44%, tech., light, bbl., lb	.06¼- .06½	.06¼- .06½	.6¼ - .6½
Muriatic, 18°, tanks, cwt	1.05 -	1.05 -	1.05 -
Nitric, 36°, carboys, lb	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18.50 -20.00
Oxalic, crystals, bbl., lb	.10¾- .12	.10¾- .12	.10¾- .12
Phosphoric, tech., c'bys., lb	.07½- .08½	.07½- .08½	.09 - .10
Sulphuric, 60°, tanks, ton	13.00 -	13.00 -	13.00 -
Sulphuric, 66°, tanks, ton	16.50 -	16.50 -	16.50 -
Tannic, tech., bbl., lb	.40 - .45	.40 - .45	.40 - .45
Tartaric, powd., bbl., lb	.27½-	.27½-	.24½-
Tungstic, bbl., lb	2.75 -	2.75 -	2.75 -
Alcohol, Amyl	-	-	-
From Pentane, tanks, lb	.101-	.106-	.123-
Alcohol, Butyl, tanks, lb	.08 -	.08½-	.08½-
Alcohol, Ethyl, 190p'f., bbl., gal	4.54 -	4.54 -	4.14 -
Denatured, 190 proof			
No. 1 special, dr., gal wks	.28 -	.28 -	.34 -
Alum, ammonia, lump, bbl., lb	.03½- .04	.03½- .04	.03 - .04
Potash, lump, bbl., lb	.03¾- .04	.03¾- .04	.03½- .04
Aluminum sulphate, com bags cwt	1.15 - 1.40	1.15 - 1.40	1.35 - 1.50
Iron free, bg., cwt	1.30 - 1.55	1.30 - 1.55	2.00 - 2.25
Aqua ammonia, 26°, drums, lb	.02 - .03	.02 - .03	.02½- .03
tanks, lb	.02 - .02¾	.02 - .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb	.15½-	.15½-	.15½- .16
tanks, lb	.04½-	.04½-	.04½-
Ammonium carbonate, powd tech., casks, lb	.08 - .12	.08 - .12	.08 - .12
Sulphate, wks., cwt	1.40-	1.40 -	1.475-
Amylacetate tech., tanks, lb	.9½ -	.09½- .12	.11 - .11½
Antimony Oxide, bbl., lb	.11 - .12	.11½- .12	.12½- .13
Arsenic, white, powd., bbl., lb	.03 - .03½	.03 - .03½	.03 - .03½
Red, powd., kegs, lb	.15½- .16	.15½- .16	.15½- .16
Barium carbonate, bbl., ton	52.50 -57.50	52.50 -57.50	52.50 -57.50
Chloride, bbl., ton	79.00 -81.00	79.00 -81.00	79.00 -81.00
Nitrate, cask, lb	.07 - .08	.07 - .08	.07 - .08
Blanc fixe, dry, bbl., lb	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f. o b., wks., drums, cwt	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, gran., bags, ton	48.00 -51.00	48.00 -51.00	46.00 -51.00
Bromine, cs., lb	.30 - .32	.30 - .32	.30 - .32
Calcium acetate, bags	1.65 -	1.65 -	1.65 -
Arsenate, dr., lb	.06½- .07	.06½- .07	.06½- .07
Carbide drums, lb	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., del., ton	21.50 -24.50	21.50 -24.50	20.00 -33.00
flake, dr., del., ton	23.00 -25.00	23.00 -25.00	22.00 -35.00
Phosphate, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Carbon bisulphide, drums, lb	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb	.04¾- .05½	.04¾- .05½	.05½- .06
Chlorine, liquid, tanks, wks., lb	2.00 -	2.00 -	2.15 -
Cylinders	.05½- .06	.05½- .06	.05½- .06
Cobalt oxide, cans, lb	1.67 - 1.70	1.67 - 1.70	1.67 - 1.70
Copperas, bgs., f.o.b., wks., ton	15.00 -16.00	15.00 -16.00	15.00 -16.00
Copper carbonate, bbl., lb	.10 - .16½	.10 - .16½	.09 - .16
Sulphate, bbl., cwt	4.50- 4.75	4.50 - 4.75	4.25 - 4.50
Cream of tartar, bbl., lb	.22½- .23	.22½- .23	.19½- .20
Diethylene glycol, dr., lb	.22 - .23	.22 - .23	.22 - .23
Epsom salt, dom., tech., bbl., cwt	1.80 - 2.00	1.80 - 2.00	1.80 - 2.00
Ethyl acetate, drums, lb	.061-	.06½-	.06½-
Formaldehyde, 40%, bbl., lb	.05¾- .06½	.05¾- .06½	.05¾- .6½
Furfural, dr., lb	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, ref. drums, lb	.12½- .14	.12½- .14	.12½- .14
Glaubers salt, bags, cwt	.95 - 1.00	.95 - 1.00	.95 - 1.00
Glycerine, c.p., drums, extra, lb	.12½-	.12½-	.15½-
Lead:			
White, basic carbonate, dry casks, lb	.07 -	.07 -	.06½-
White, basic sulphate, sck., lb	.06½-	.06½-	.06½-
Red, dry, sck, lb	.0735-	.0735-	.074-
Lead acetate, white crys., bbl., lb	.10 - .11	.10 - .11	.11 - .12
Lead arsenate, powd., bbl., lb	.11 - .11½	.11 - 11½	.13 - .13½
Lime, chem., bulk, ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk., lb	.0635-	.0635-	.06 -
Lithophone, bags, lb	.04½- .04¾	.04½- .04¾	.04½- .05
Magnesium carb., tech., bags, lb	.06 - .06½	.06 - .06½	.06 - .06½

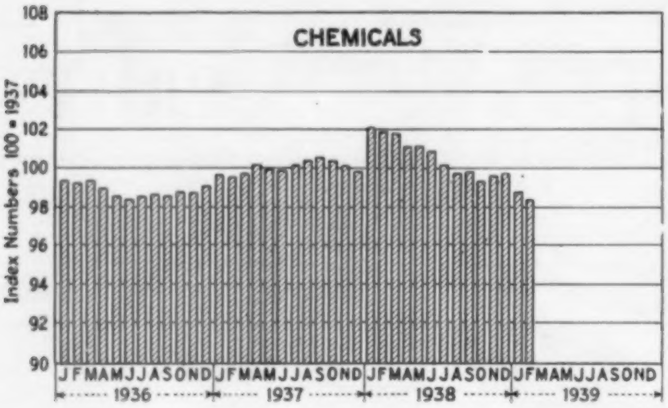
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Feb. 15

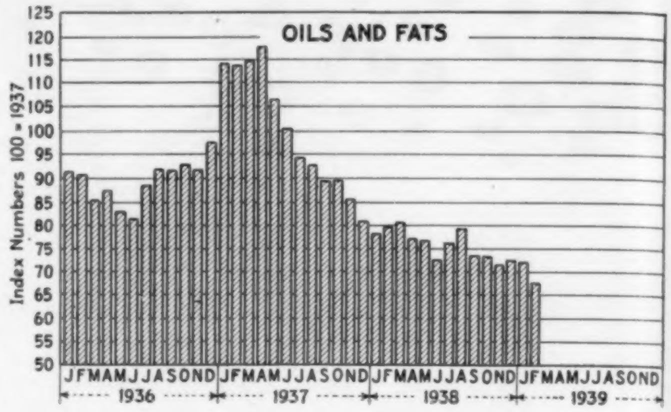
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal	.31 -	.31 -	.31 -
97%, tanks, gal	.32 -	.32 -	.32 -
Synthetic, tanks, gal	.33 -	.33 -	.33 -
Nickel salt, double, bbl., lb	.13 - .13½	.13 - .13½	.13 - .13½
Orange mineral, csk., lb	.10½-	.10½-	.10½-
Phosphorus, red, cases, lb	.40 - .42	.40 - .42	.40 - .42
Yellow, cases, lb	.18 - .25	.18 - 25	.24 - .30
Potassium bichromate, casks, lb	.08¾- .09	.08¾- .09	.08¾- .09
Carbonate, 80-85%, calc. csk., lb	.06½- .07	.06½- .07	.-06½ .07
Chlorate, powd., lb	.09½-	.09½-	.09½-
Hydroxide (c'stic potash) dr., lb	.07 - .07½	.07 - .07½	.07 - .07½
Muriate, 80% bgs., unit	.53½-	.53½-	.53½-
Nitrate, bbl. lb	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb	.18½- .19	.18½- .19	.18½- .19
Prussate, yellow, casks, lb	.14 - .15	.15 - .16	.15 - .16
Sal ammoniac, white, casks, lb	.05 - .05½	.05 - .05½	.05 - .05½
Salsoda, bbl., cwt	1.00 - 1.05	1.00 - 1.05	1.00 - 1.05
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	13.00 -15.00
Soda ash, light, 58%, bags, contract, cwt	1.05 -	1.05 -	1.05 -
Dense, bags, cwt	1.10 -	1.10 -	1.10 -
Soda, caustc, 76%, solid, drums, contract, cwt	2.30 - 3.00	2.30 - 3.00	2.30 - 3.00
Acetate, works, bbl., lb	.04 - .05	.04 - .05	.04½- .05
Bicarbonate, bbl., cwt	1.70 - 2.00	1.70 - 2.00	1.75 - 2.00
Bichromate, casks, lb	.06¾- .07	.06¾- .07	.06¾- .07
Bisulphate, bulk, ton	15.00 -16.00	15.00 -16.00	15.00 -16.00
Bisulphite, bbl., lb	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb	.06½- .06¾	.06½- .06¾	.06½- .06¾
Cyanide, cases, dom., lb	.14 - .15	.14 - .15	.16½- .17
Fluoride, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Hyposulphite, bbl., cwt	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt	2.20 - 3.20	2.20 - 3.20	2.15 - 3.15
Nitrate, bags, cwt	1.45 -	1.45 -	1.45 -
Nitrite, casks, lb	.06½- .07	.06½- .07	.07 - .08
Phosphate, dibasic, bags, lb	1.85 -	1.85 -	1.85 - .024
Prussiate, yel. drums, lb	.09½- .10	.09½- .10	.10 - .11
Silicate (40° dr.) wks., cwt	.80 - .85	.80 - .85	.80 - .85
Sulphide, fused, 60-62%, dr., lb	.02½- .03½	.02½- .03	.02½- .03
Sulphite, cyrs., bbl., lb	.02½- .02½	.02½- .02¾	.02½- .02¾
Sulphur, crude at mine, bulk, ton	16 00 -	16.00 -	18.00-
Chloride, dr., lb	.03 - .04	.03 - .04	.03½- .04
Dioxide, cyl., lb	.07 - .08	.07 - .08	.07 - .07½
Flour, bag, cwt	1.60 - 3.00	1.60 - 3.00	1.60 - 3.00
Tin Oxide, bbl., lb	.50 -	.50 -	.47 -
Crystals, bbl., lb	.35½-	.36½-	.33 -
Zinc. chloride, gran., bbl., lb	.05 - .06	.05 - .06	.05 - .06
Carbonate, bbl., lb	.14 - .15	.14 - .15	.14 - .15
Cyanide, dr., lb	.33 - .35	.33 - .35	.36 - .38
Dust, bbl., lb	.06½-	.06½-	.06½-
Zinc oxide, lead free, bag., lb	.06½-	.06½-	.06½-
5% lead sulphate, bags, lb	.06¾-	.06¾-	.06½-
Sulphate, bbl., cwt	2 75 - 3.00	2 75 - 3.00	3.15 - 3.60

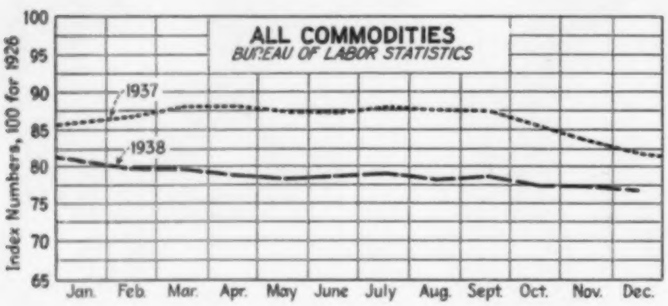
OILS AND FATS

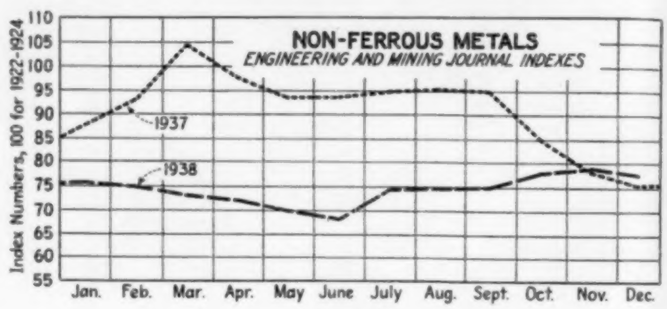
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.09½-$0.10	$0.09½-$0.10	$0.09½-$0.10
Chinawood oil, bbl., lb	.14½-	.15½-	.15 -
Coconut oil, Ceylon, tanks, N. Y. lb	.03 -	.03 -	.03½-
Corn oil crude, tanks (f.o.b. mill), lb	.05¾-	.06 -	.07½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.05¾-	.06½-	.06¾-
Linseed oil, raw car lots, bbl., lb	.085-	.085-	.099-
Palm, casks, lb	.03½-	.03¾-	.04½-
Peanut oil, crude, tanks (mill), lb	.05¾-	.06½-	.06½-
Rapeseed oil, refined, bbl., gal	.80 -	.80 -	.90 -
Soya bean, tank, lb	.04¾-	.05½-	.06½-
Sulphur (olive foots), bbl., lb	.07 -	.07 -	.09½-
Cod, Newfoundland, bbl., gal	.38 -	.38 -	.52 -
Menhaden, light pressed, bbl., lb	.07 -	.071-	.074-
Crude, tanks (f.o.b. factory), gal	.30 -	.32 -	.37½-
Grease, yellow, loose, lb	.04¾-	.04¾-	.04¾-
Oleo stearine, lb	.06½-	.06½-	.07½-
Oleo oil, No. 1	.07½-	.08½-	.09½-
Red oil, distilled, d.p. bbl., lb	.07¾-	.07¾-	.09¾-
Tallow extra, loose, lb	.05½-	.05½-	.05½-

Chem. & Met.'s Weighted Price Indexes









COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb	$0.52 -$0.55	$0.52 -$0.55	$0.52 -$0.55
Alpha-naphthylamine, bbl., lb	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb	.15 - .16	.15 - .16	.15 - .16
Aniline salts, bbl., lb	.22 - .24	.22 - .24	.22 - .24
Benzaldehyde, U.S.P., dr., lb	.85 - .95	.85 - .95	.85 - .95
Benzidine base, bbl., lb	.70 - .75	.70 - .75	.70 - .75
Benzoic acid, U.S.P., kgs., lb	.54 - .56	.54 - .56	.52 - .54
Benzyl chloride, tech., dr., lb	.23 - .25	.23 - .25	.25 - .27
Benzol, 90%, tanks, works, gal	.16 - .18	.16 - .18	.16 - .18
Beta-napthol, tech., drums, lb	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb	.10 - .11	.10 - .11	.12 - .13
Cresylic acid, dr., wks., gal	.69 - .71	.69 - .71	.89 - .92
Diethylaniline, dr., lb	.40 - .45	.40 - .45	.50 - .55
Dinitrophenol, bbl., lb	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluen, bbl., lb	.15 - .16	.15 - .16	.15 - .16
Dip oil, 15%, dr., gal	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb	.32 - .36	.32 - .36	.32 - .36
H-acid, bbl., lb	.50 - .55	.50 - .55	.50 - .55
Naphthalene, flake, bbl., lb	.05½- .06	.05½- .06	.07½- .07¾
Nitrobenzene, dr., lb	.08 - .09	.08 - .09	.08 - .09
Para-nitraniline, bbl., lb	.47 - .49	.47 .49	.45 - .47
Phenol, U.S.P., drums, lb	.14½-......	.14½-......	.14½-......
Picric acid, bbl., lb	.35 - .40	.35 - .40	.35 - .40
Pyridine, dr., gal	1.55 - 1.60	1.55 - 1.60	1.55 - 1.60
Resorcinal, tech., kegs, lb	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb	.33 - .40	.33 - .40	.34 - .40
Solvent naptha, w.w., tanks, gal	.26 -......	.26 -......	.30 -......
Tolidine, bbl., lb	.86 - .88	.86 - .88	.88 - .90
Toluene, tanks, works, gal	.27 -......	.27 -......	.35 -......
Xylene, com, tanks, gal	.26 -......	.26 -......	.35 -......

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb	.08½- .11	.08½- .11	.09½- .12
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors			
Carbon gas, black (wks.), lb	.02½- .30	.02½- .30	.02½ .30
Prussian blue, bbl., lb	.36 - .37	.36 - .37	.36 .37
Ultramarine blue, bbl., lb	.10 - .26	.10 - .26	.10 - .26
Chrome green, bbl., lb	.21 - .30	.21 - .30	.21 - .27
Carmine red, tins, lb	4.00 - 4.40	4.00 - 4.40	4.00 - 4.40
Para toner, lb	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb	1.56 - 1.60	1.46 - 1.44	1.55 - 1.65
Chrome yellow, C. P., bbl., lb	.14½- .15½	.14½- .15½	.14½ .15½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb	.06 - .06½	.06 - .06½	.06 - .06½
Gum copal Congo, bags, lb	.06 - .30	.06 - .30	.08 - .30
Manila, bags, lb	.07 - .14	.07 - .14	.09 - .14
Damar, Batavia, cases, lb	.16 - .24	.16 - .24	.16 - .24
Kauri cases, lb	.17½- .60	.17½- .60	.18½- .60
Kieselguhr (f.o.b. N. Y.), ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -......	50.00 -......	50.00 -......
Pumice stone, lump, bbl., lb	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb	.03 - .04	.03 - .04	.03 - .04
Rosin, H., bbl	6.50 -......	6.10 -......	7.05 -......
Turpentine, gal	.30½-......	.30½-......	.31 -......
Shellac, orange, fine, bags, lb	.20 -......	.20 -......	.21 -......
Bleached, bonedry, bags, lb	.19 -......	.19 -......	.17 -......
T. N. Bags, lb	.10½-......	.10½-......	.12 -......
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton	13.75 -......	13.75 -......	13.75 -......

INDUSTRIAL NOTES

SPROUT, WALDRON & CO., Muncy, Pa., has opened a New York office at 50 Church St., with David E. Smyth in charge.

BUFFALO FOUNDRY AND MACHINE CO., Buffalo, has promoted Charles W. Pearson, vice-president and sales manager, to the position of executive vice-president and general manager.

ELLIS-FOSTER CO., Montclair, N. J., has moved from 92 Greenwood Ave., to the new laboratory building at 4 Cherry St. Ellis Laboratories, Inc., remains at the former address.

ELECTRO METALLURGICAL CO., New York, has elected as vice-presidents, James H. Critchett in charge of research work and Francis B. Morgan, works manager.

DENVER EQUIPMENT CO., Denver, Colo., has moved into its new building at 1400 Seventeenth St. The building is illuminated by new day-light fluorescent tubes.

FOOTE BROS. GEAR AND MACHINE CORP., Chicago, has appointed as representatives: A. C. Andrews, Dallas, Texas; W. M. Lee, Houston, Texas; and Industrial Engineering Co., Charleston, W. Va.

W. S. ROCKWELL CO., New York, has appointed Firmin & Keown, Commonwealth Bldg., Pittsburgh, as representative in Western Pennsylvania.

UNITED STATES RUBBER CO., New York, has appointed Frank M. Urban assistant manager of Mechanical Goods Division, Chicago Branch. The Baltimore Branch is now under direction of R. F. Jackson.

EDGE MOOR IRON WORKS, INC., New York, is now represented in the Chicago district by the Cochrane Engineering Co., 53 West Jackson Blvd.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cummulative 1939	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$110,000	....	$160,000	$40,000
Middle Atlantic	1,050,000	$60,000	2,230,000	98,000
South	1,250,000	298,000	1,790,000	45,000
Middle West	....	600,000	270,000	......
West of Mississippi	40,000	200,000	680,000	275,000
Far West	80,000	676,000	80,000	626,000
Canada	1,980,000	40,000	2,800,000	115,000
Total	$4,510,000	$1,874,000	$8,010,000	$1,199,000

PROPOSED WORK

Alcohol Distillery—Syndicate c/o S. G. Mooney, County Clerk, Perth, N. B., Can., plans to construct an alcohol distillery. Estimated cost $40,000.

Calcium Carbonate Factory—White Valley Chemicals, Ltd., H. A. MacGrath, Mgr., Lumsden Bldg., Toronto, Ont., Can., plans to construct a factory to produce calcium carbonate near Bobcaygeon, Ont. Estimated cost $40,000.

Chemical Plant — Richards Chemical Works, Ltd., St. Johns, Que., Can., plans to construct an addition to its plant in the Spring. Estimated cost $40,000.

Cosmetics Factory — Western Pacific Chemical Laboratories, Inc., N. W. Industrial Bldg., Seattle, Wash., plans to construct a factory to be occupied by Dermetics, Inc., at Elliott Ave. and Lee St., Seattle. H. G. Hammond, Textile Tower, Seattle, Archt. Estimated cost $40,000.

Laboratory—Weirton Steel Co., Main St., Weirton, W. Va., will soon award contract for the construction of a laboratory to include chemical, metallurgical and research units. Estimated cost including equipment $250,000.

Factory—Canadian Bitumuls Co., Ltd., Leaside, Ont., Can., plans to construct a new plant at Vancouver, B. C., Can. Estimated cost $150,000.

Laboratory—New York State Dept. of Agriculture, State Office Bldg., Albany, N. Y., plans to construct a laboratory building in connection with other buildings at the State Agricultural School, Alfred, N. Y. Estimated cost of complete project $1,000,000.

Natural Gas Development — Belmont Quadrangle Co., Jack B. Cleaves, Secy., Box 373, Bradford, Pa., plans extensive development of new established Oriskany sand natural gas producing area near Woodhull, N. Y. Project includes drilling a number of 5,000 ft. wells, gathering pipe lines, etc. Bids are now being received. Estimated cost $50,000.

Oil Refinery—Consolidated Refinery Co., Ltd., c/o G. Murray Bayne, K. C., Regina, Sask., Can., is having plans prepared for the construction of an oil refinery. Estimated cost $100,000.

Oil Refinery—Danciger Oil & Refining Co., Longview, Tex., plans to construct a crude oil refinery to have a daily capacity of 6,000 bbl. at Corpus Christi, Tex.

Oil Refinery—Imperial Oil Co., Ltd., 56 Church St., Toronto, Ont., Can., plans to construct additions to its refinery at Fort Norman, Toronto.

Paper Mill—A.P.W. Paper Co., Bridge St., Albany, N. Y., plans to construct a paper manufacturing plant at Jacksonville, Fla. Estimated cost will exceed $1,000,000.

Paper Mill—Rising Paper Co., Housatonic, Mass., is receiving bids for the construction of a 2 story, 35x200 ft. addition to its mill. Estimated cost $60,000.

Veneer Factory—Pacific Veneer Co., Ltd., 640 West Pender St., Vancouver, B. C., Can., is having plans prepared by Arthur Pearson, Engr., 850 West Hastings St., Vancouver, B. C., for the construction of a factory. Estimated cost $70,000.

Smelter—Quebec Provincial Government, Department of Mines, Quebec, Que., Can., will soon receive bids for the construction of a zinc smelter and sulphur and iron oxide plant near Rouyn, Que. Estimated cost $1,500,000.

Sugar Refinery — Holly Sugar Corp., Dyer Sta., Santa Ana, Calif., plans to construct a dumping plant. Estimated cost $40,000.

Tobacco Experimental Station—State of Connecticut, R. A. Hurley, Comr. Public Works, Hartford, Conn., plans to construct a tobacco experimental station to include laboratory research facilities at Windsor, Conn. Frederick J. Dixon, State Office Bldg., Hartford, Archt. Estimated cost $50,000.

CONTRACTS AWARDED

Asphalt Blending Plant—Col-Tex Refining Co., Colorado, Tex. (branch of Anderson-Prichard Oil Corp., Oklahoma City, Okla.) plans to construct an asphalt blending plant at Corpus Christi, Tex. Work will be done by owners by day labor and separate contracts. Estimated cost $100,000.

China Factory — Edwin M. Knowles China Co., Newell, W. Va., has awarded the contract for a 1 story, 136x164 ft. addition to its factory to Petters Lumber Co., East Liverpool, O. Estimated cost $40,000.

Gas System—City, Bay St. Louis, Miss., has awarded the contract for the construction of a natural gas system to Littrell Contracting Co., Opelousas, La., $184,820.

Laboratory—City, Kingston, N. Y., will construct a laboratory building. Work will be done by relief labor. Estimated cost $60,000. Teller & Halverson, 280 Wall St., Kingston, N. Y. Archts.

Laboratory—U. S. Department of Agriculture, Wash., D. S., has awarded the contract for a 2 story, 42.6x72.6 ft. laboratory building at Oxford, N. C., to V. P. Loftis, Builders Bldg., Charlotte, N. C. Estimated cost $72,800.

Oil Refinery—General Petroleum Corp. of California, 417 Montgomery St., San Francisco, Calif., has awarded the contract for a distributing plant, including warehouse, loading rack, pump house, etc. at Soledad, Calif., to F. N. Franscioni, Soledad; warehouse at Gilroy, Calif., to W. Radtke, 180 Elgieberry St., Gilroy. Estimated cost will exceed $40,000.

Oil Refinery—Richfield Oil Co., Richfield Oil Bldg., Los Angeles, Calif., has awarded the contract for cold acid treating plant at its Watson Refinery to Bechtel-McCone-Parsons Co., 610 West 5th St., Los Angeles. Estimated cost $500,000.

Oil Refinery—Zane Refining Co., P. N. Faine, Secy., c/o Ohio Penn Grade Oil Producers Assn., Zanesville, O., has awarded separate contracts for preliminary work for proposed crude oil refinery to be constructed at Zanesville, O. Bids will soon be asked for superstructures and equipment. Estimated cost $500,000.

Oxygen Factory—Stuart Oxygen Co., 211 Bay St., San Francisco, Calif., has awarded the contract for the construction of a factory for the manufacture of oxygen at Vernon, Calif., to Bechtel, McCone & Parsons, 601 West 5th St., Los Angeles. Estimated cost $50,000.

Paper Box Factory—Anheuser-Busch, Inc., 721 Pestalozzi St., St. Louis, Mo., has awarded the contract for reconstructing and remodeling five factory buildings on east side of Dorcas St. and constructing new 1 story, 275x300 ft. building to L. O. Stocker Co., 1102 Arcade Bldg., St. Louis, Mo. Factory will be leased to Gaylord Container Corp., 2820 South 11th St., St. Louis, for the manufacture of paper boxes and cartons. Estimated cost $100,000.

Soy Bean Processing Plant—Soy Bean Processing Co., Wooster, O., has awarded the contract for the construction of a plant to Newell Construction & Machinery Co., Cedar Rapids, Ia. Estimated cost $100,000.

Tobacco Factory—Imperial Tobacco Co., Ltd., 3810 St. Antoine St., Montreal, Que., Can., has awarded the contract for a 1 story, 100x220 ft. addition to its factory to Hein Construction Co., Ltd., 172 Aylmer St., Windsor, Ont.

Storage Building—U. S. Rubber Co., 5225 Anaheim St., Los Angeles, Calif., has awarded the contract for the construction of a storage building at its plant at 5725 Telegraph Rd., Bardini District, to W. P. Neil Co., 4814 Loma Vista St., Los Angeles. Estimated cost $86,000.

Chemical ECONOMICS and MARKETS

CONSUMING INDUSTRIES INCREASED CALL FOR CHEMICALS IN PRESENT MONTH

WITH an apparent leveling off of production and consumption activities in January, there has been a rising trend since the turn of the month which has been fairly well divided among the various branches of industry. Some adverse factors have arisen, such as delays in delivering parts which cut down automotive production, but the general situation currently is of a better tone and business has reacted accordingly.

With data complete, it is found that consumption of chemicals in December was measured by the index number of 112.77 according to the *Chem & Met.* index. This is about what had been indicated in the preliminary index, with the fertilizer industry registering a seasonal

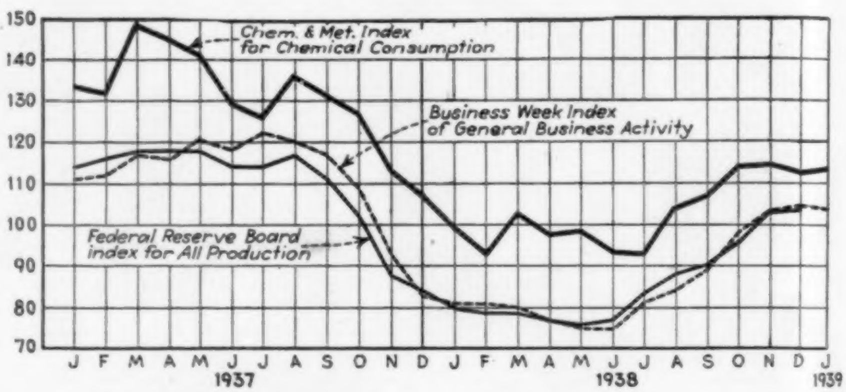
Chem. & Met. Index for Consumption of Chemicals

	November (Revised)	December
Fertilizer	25.83	27.34
Pulp and paper	15.20	13.98
Glass	10.61	10.39
Petroleum refining	12.66	12.84
Paint and varnish	8.60	6.60
Iron and steel	7.90	7.09
Rayon	8.09	8.41
Textiles	7.40	7.28
Coal products	6.39	6.85
Leather, glue and gelatine	3.68	3.62
Explosives	4.30	4.15
Rubber	2.56	2.56
Plastics	1.60	1.66
	114.82	112.77

gain and advances in oil refining and sulphate of ammonia production. Most other industries, however, reported moderate seasonal year-end recessions.

From incomplete data the index for January is placed at 114.00 and judging from trade reports the February index will show a relative rise from the January level. Most encouraging reports come from the glass, pulp and paper, textile, leather, and rubber industries.

Reports on the movement of chemicals for the year to date reveal some spotty conditions with moderate gains in shipment cited for some products and large increases for others. Carbon black shipments in the latter part of last year were stimulated by the probability of higher prices for deliveries for January



forward. This increase was not carried into effect yet there was some stocking up of this material and in view of that fact January deliveries held up surprisingly well. The steady rate of operations at textile plants, particularly in the wool and silk divisions has been reflected in the call for chemicals associated with those fields. Steel plants have been picking up momentum and the use of sulphuric acid is said to have shown better than relative gains.

While earlier estimates, which predicted very high gains for the building trades, have been modified the change has been merely in degree of increase and the outlook is very promising. This is regarded as favoring a wider use of raw materials which enter into paint and varnish manufacture.

Coal-tar chemicals are moving out freely. Benzol production was at a low ebb last year and stocks have not been large at any time and the same is true for solvent naphtha and xylol. Foreign markets have reported weakness in naphthalene and lower prices have been quoted on import business.

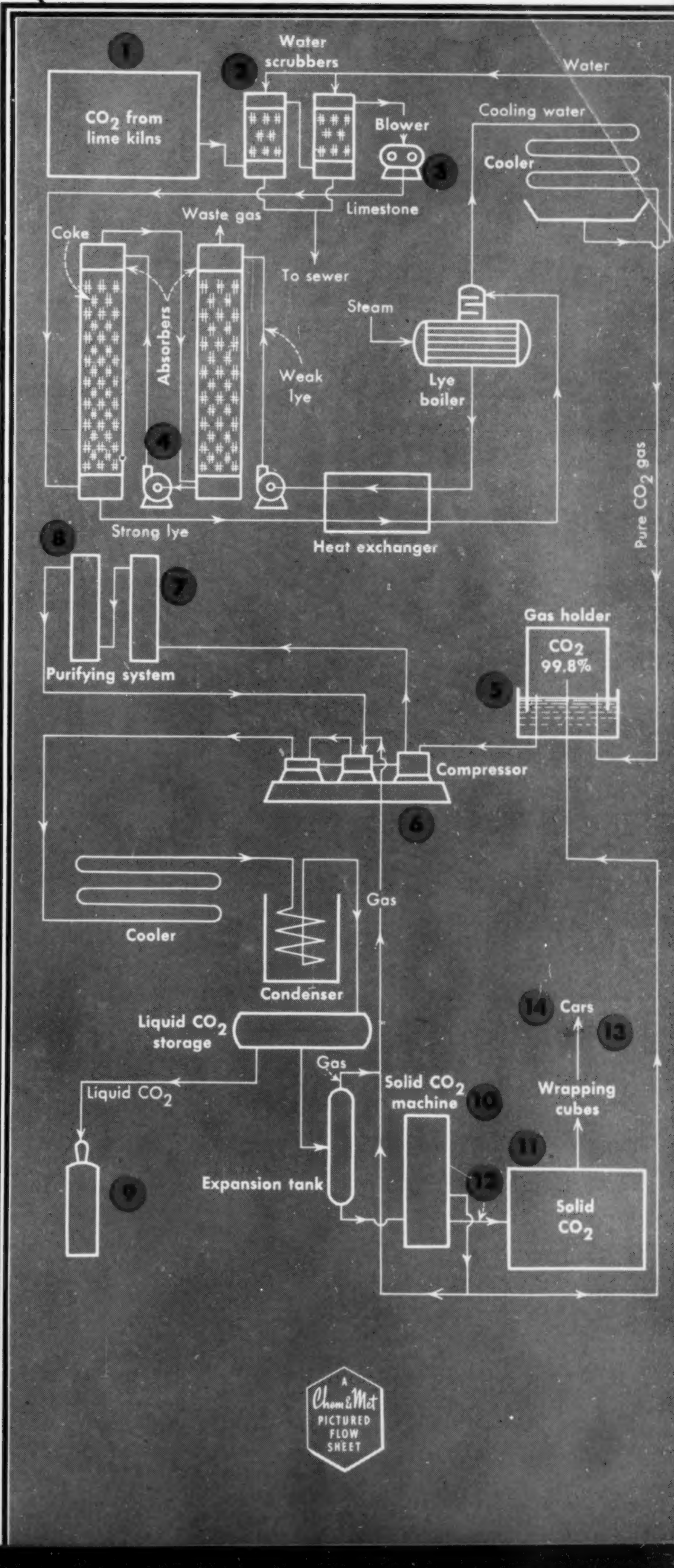
Paint-making materials hold a steady position with firmness reported for some selections. The rise in quicksilver has been passed on to vermilion and a recent advance in lead may later affect the pigments particularly the oxides. Spirits of turpentine and rosin have been more strongly held and while no marked gains in trading have been noted, there is a disposition to advance quotations due partly to a belief that consumers will be more active in the market in the near future and partly because of reports that the stocks held in the interior are light and that port stocks will be heavily drawn upon before new crop deliveries come on the market.

The solvents group which has been featured by lower prices for many of the products made no price recoveries in the past month—in fact the list of commodities to be lowered was extended—is faced with better prospects so far as tonnage is concerned but inter-commodity competition remains keen. Acetone, which was in large supply for part of last year, reached a high point for the last decade in the export trade of last year, a total of 10,000,000 gal. having been shipped out in the first 11 months.

Production and Consumption Data for Chemical Consuming Industries

Production	1938 Dec.	1937 Dec.	1938 Jan.-Dec.	1937 Jan.-Dec.	Per cent of decline for 1938
Alcohol, ethyl, 1000 pr. gal	16,772	17,362	192,628	215,438	11.8
Alcohol denatured, 1000 wi. gal	10,500	7,012	92,967	99,078	6.6
Automooiles, no	388,346	326,234	2,389,555	4,808,974	50.3
Benzol, 1000 gal	7,802	6,340	71,362	117,014	39.0
Byproduct coke, 1000 tons	3,363	2,824	31,796	49,211	35.4
Glass containers, 1000 gr	3,515	3,235	43,103	52,665	18.2
Plate glass, 1000 sq. ft	12,601	8,921	85,725	192,593	58.2
Cellulose acetate plastics, 1000 lb	1,112	624	6,831	13,235	48.4
Nitrocellulose plastics, 1000 lb	789	602	9,488	17,722	46.5
Rubber reclaimed, tons	14,712	11,162	114,687	179,517	36.1
Methanol, crude, gal	357,249	461,539	4,170,096	5,753,595	27.5
Mentanhol, synthetic, gal	2,844,249	3,887,741	26,031,169	31,814,046	18.2
Consumption					
Cotton, bales	565,307	432,328	5,905,365	7,420,267	20.4
Silk, bales	35,204	21,982	411,794	425,299	3.2
Wool, 1000 lb	39,189	13,282	284,509	353,466	19.5
Explosives, 1000 lb	28,415	27,284	320,289	387,805	17.4
Rubber, tons	45,315	29,195	411,363	512,223	19.7
Waste paper, tons	221,768	196,231	2,788,071	3,409,970	18.3

CARBON DIOXIDE *from* LIME KILN GASES



Any industry that can double its production in the brief space of two years can be justly proud of the progress. Such is the accomplishment of the solid carbon dioxide manufacturers whose production jumped from 165,123,912 lb. in 1935 to the amazing figure of 313,217,310 in 1937. The liquid branch of the industry too experienced an increase although it was not so spectacular. If there were figures available for the past year they would probably show that this young industry already had passed the $10,000,000 mark.

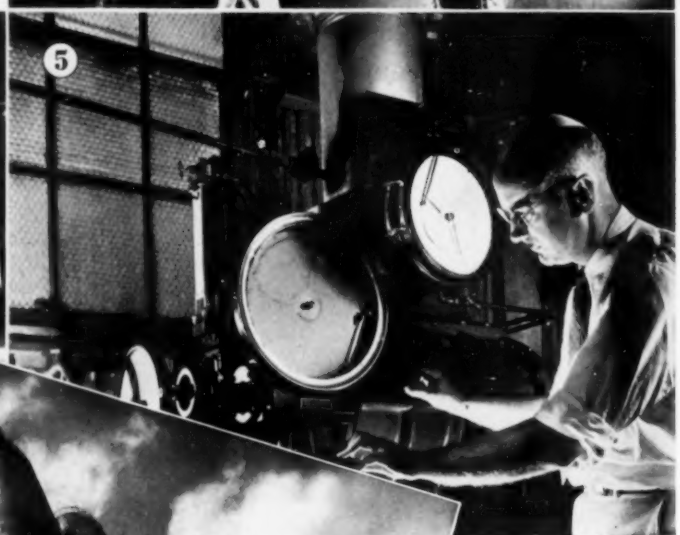
The enormous growth in popularity of dry ice is due to recognition of its value in the preparation, storage and handling of food products. For ice cream it has almost entirely supplanted water ice. For quick frozen foods, the shipment of flowers and for shrinking castings it is often used. The liquid form is used for a great variety of applications, such as the carbonation of beverages, fire extinguishers and non-explosive cartridges for mining operations.

One of the largest of the plants in the entire South is that of the Mathieson Alkali Works at Saltville, Va. This plant is operated in conjunction with an ammonia-soda process upon which it depends for raw material. The calcium carbonate precipitated in the causticizing operation is burned to recover the lime, and the gases passing from the kiln are conveyed to the solid and liquid carbon dioxide plant. The gases must be highly purified because the products come in direct contact with foods. Various steps in the process are shown in the diagrammatic flow sheet. Many of these are illustrated by the accompanying photographs, to which the numbers refer, recently taken in the Mathieson plant.

1 At the Saltville, Va., ammonia-soda plant of Mathieson Alkali Works, the gas from the recovery operation is used in producing solid and liquid carbon dioxide

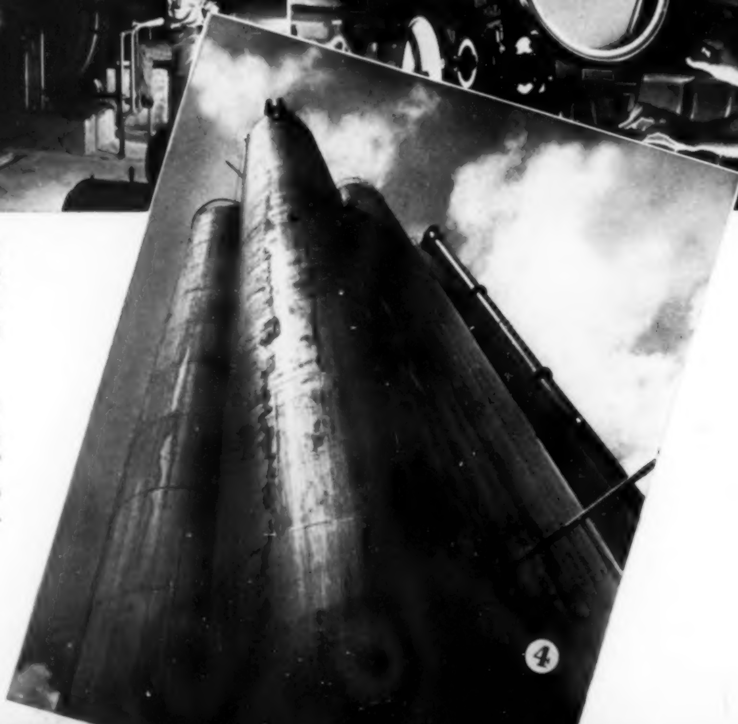
2 First purifying operation is the removal of dust and water-soluble gases from the kiln gas. Gages facilitate close control over operation of water scrubbers.

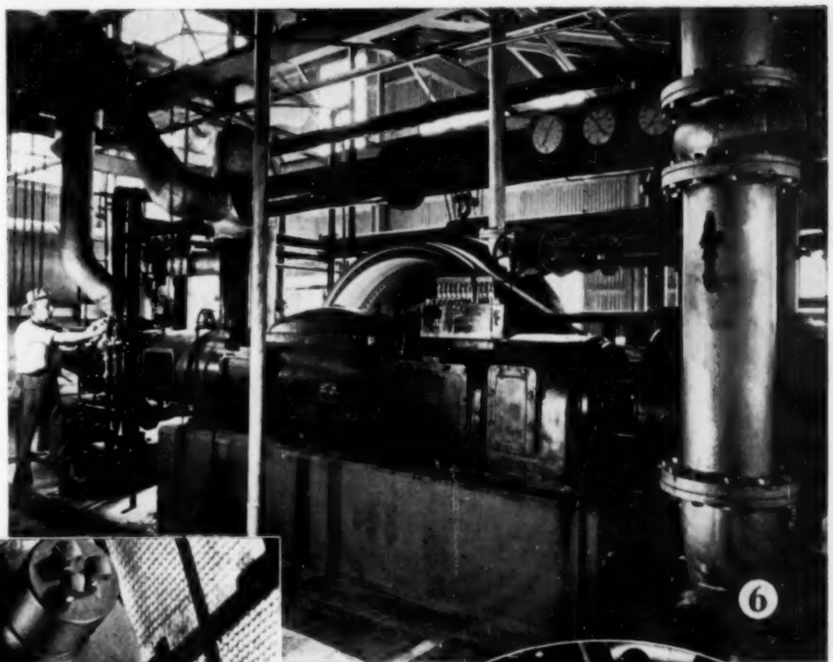
3 Power to pull the kiln gas through scrubbers and to propel it on through absorption towers is supplied by this steam-driven blower



4 Absorption towers are connected in series for counter-current flow of gas and lye solution. Strong lye solution is pumped to steam heated boilers from the first tower

5 Lye boilers reverse the process of absorption, liberating purified carbon dioxide gas and returning "desorbed" lye solution to the system. The gas is cooled, then metered before passing into the gas holder



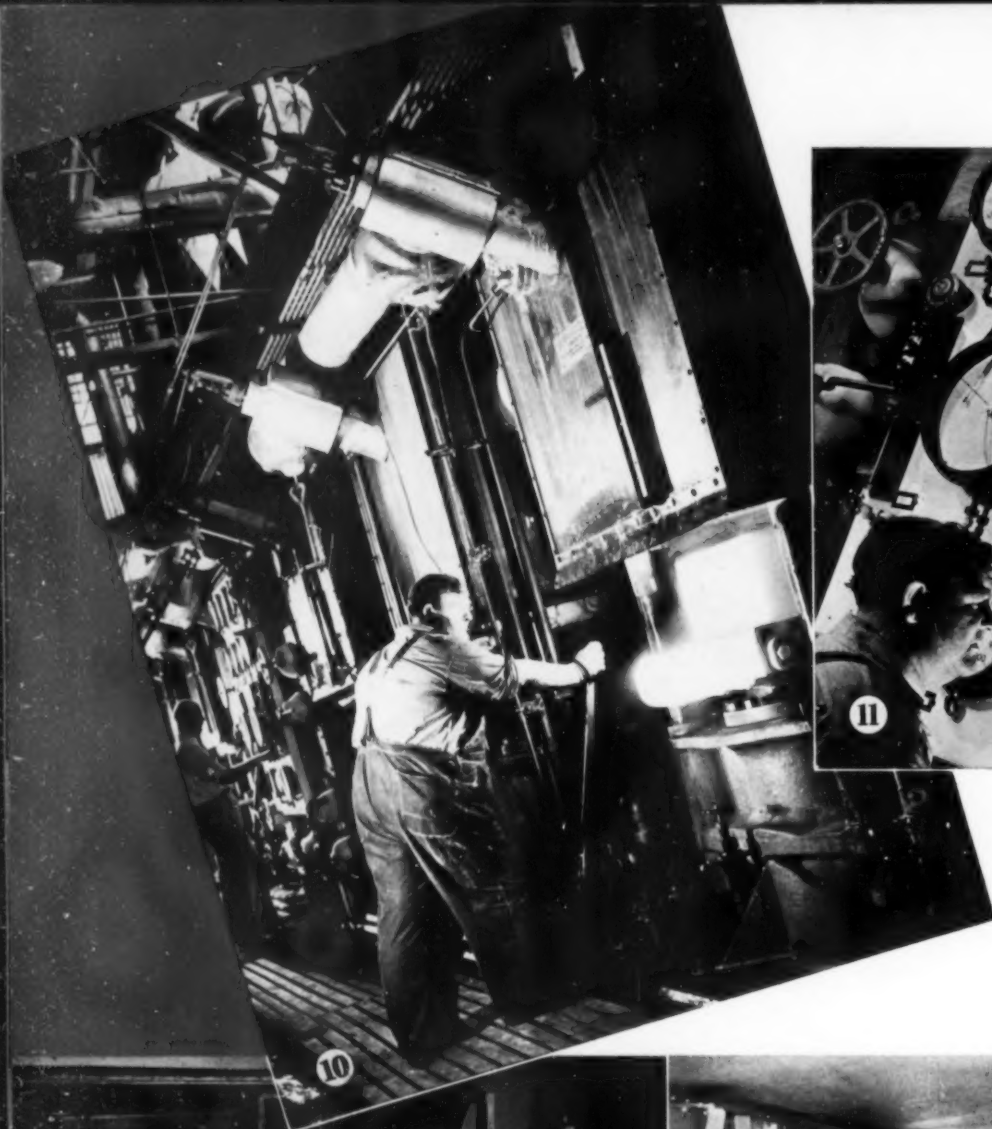


6 Pressure of the gas is raised in three-stage compressors to a point where the cooling effect of condensers will cause liquefaction, which is at temperatures only a little below the critical point

7 Extra precaution of oil separators between compressors and condenser double-checks against oil in the liquid or solid products

8 Close control of moisture in finished products is important. Here is a battery of dryers which are designed for efficient, continuous operation

9 After a thorough-going cleaning and reconditioning, carbon dioxide cylinders are purged with pure gas and then filled to exact weight on delicate scales. The cylinders are made from a chrome-molybdenum alloy



10 The snow is pressed and formed into dense, solid blocks by powerful hydraulic presses

11 Centralization of instruments facilitates control of the solid carbon dioxide operations

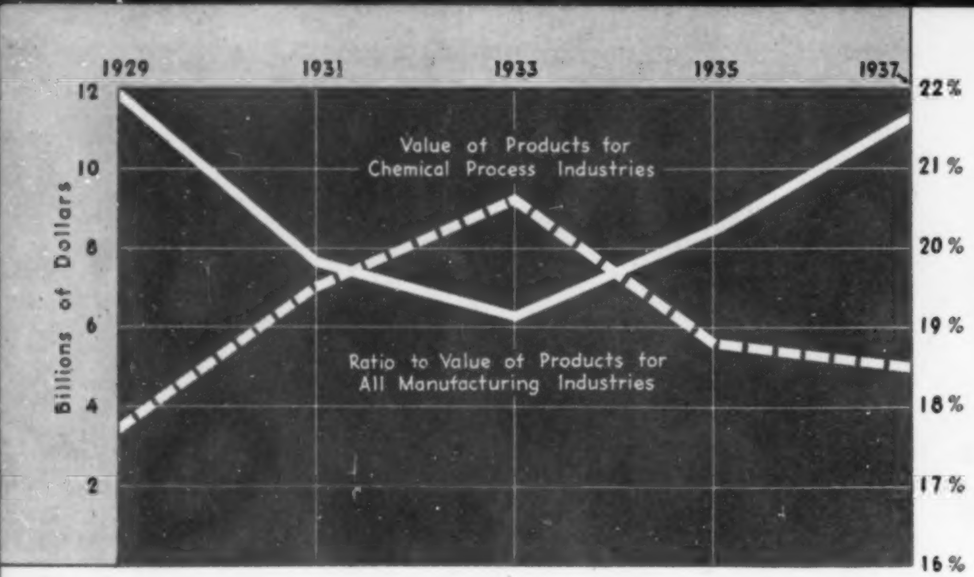
12 Blocks coming from the dry ice presses. Automatic conveyors carry them to saws which cut the blocks into cubes

13 & 14 On a par, in complexity and in importance, with problems of manufacturing dry ice are problems of efficiently distributing this perishable product. Two views of the special freight car for bulk shipments designed by Mathieson engineers give some idea of the thought and study which have gone into the distribution end of the business

16TH ANNUAL REVIEW AND STATISTICAL SECTION

HIGH LIGHTS

NEW CENSUS shows all-time high records for chemicals in 1937 . . . CONSUMPTION in most process industries dropped a fifth to a fourth in 1938 . . . HEAVY ACIDS and alkalis accurately reflected these trends . . . FERTILIZERS held better than anticipated . . . NON-FERTILIZER PHOSPHATES show many advances . . . PLASTICS off 25 per cent but final 1938 quarter best in history . . . RAYON production markedly curtailed but consumption within 3 per cent of all-time high . . . SYNTHETIC ORGANICS back to 1936 levels . . . DOMESTIC ACETIC ACID made synthetically largely displaced imports following noticeable shifts among processes . . . COKE-OVEN OPERATIONS at 1936 levels but early figures indicate much better output for 1939 . . . CHEMICAL PRICES continue long-time downward trend in line with industry's dynamic pricing policies.



PRODUCTION

COMPLETED LATE IN 1938 and earlier in the current year, the industry compilations for the new Biennial Census of Manufactures reveal some significant trends that may prove the basis for interesting and valuable comparisons. Again the chemical process industries held their own or actually went ahead of the "all industry" total. The value of products for the group as a whole was back to 95 per cent of its 1929 figure as compared with 88 per cent for all of American industry.

In 1937 the chemical process industries had 8.5 per cent of the total number of plants, but produced 18.5 per cent of the total value of products for all American industry. The latter percentage compared with 17.4 for 1929. This ratio, which always increases in times of depression, had reached 21 per cent in 1933—indicating again the relatively greater stability of the process group. Charts on this and the opposite page compare group and industry totals with 1929.

From time to time, considerable controversy has arisen in chemical industry regarding the various schemes of classification used not only by the different divisions of the government, but also by trade associations and other statistical agencies. It is difficult, if not impossible, to obtain agreement as to the best definition of chemical industry, but much confusion can be avoided when statistics are published if a statement is given to show exactly what subdivisions have been included. The detailed groupings of the chemical process industries used in *Chem. & Met.* compilations are given in the accompanying table.

Detailed Census Groupings of
The Chemical Process Industries

1. CHEMICALS
   - a. Chemicals, not elsewhere classified
     - General inorganic compounds, including acids, alkalies and salts
     - General organic chemicals, including coal tar products, dyes, synthetic organic chemicals, plastics
   - b. Compressed and liquefied gases
   - c. Insecticides and fungicides
   - d. Liquors, distilled
   - e. Photographic materials
   - f. Salt
   - g. Tanning materials, natural dyestuffs, mordants, assistants and sizes
   - h. Turpentine and rosin
   - i. Wood distillation products
2. COKE OVEN PRODUCTS
3. DRUGS, MEDICINES and COSMETICS
   - a. Drug grinding
   - b. Drugs and medicines
   - c. Perfumes, cosmetics and toilet preparations
4. EXPLOSIVES (and Fireworks)
5. FERTILIZERS
6. GLASS and CERAMICS
   - a. Glass
   - b. Clay products and refractories
   - c. Pottery, including porcelain ware
   - d. Sand-lime brick
7. LEATHER, tanned, curried and finished
8. LIME and CEMENT
9. OILS and FATS
   - a. Cottonseed oil, cake and meal
   - b. Essential oils
   - c. Grease and tallow, not including lubricating greases
   - d. Linseed oil, cake and meal
   - e. Lubricating greases, not made in petroleum refineries
   - f. Oils, not elsewhere classified
10. PAINTS, PIGMENTS, VARNISH and LACQUER
11. PAPER and PULP
12. PETROLEUM PRODUCTS
13. RAYON (and Allied Products)

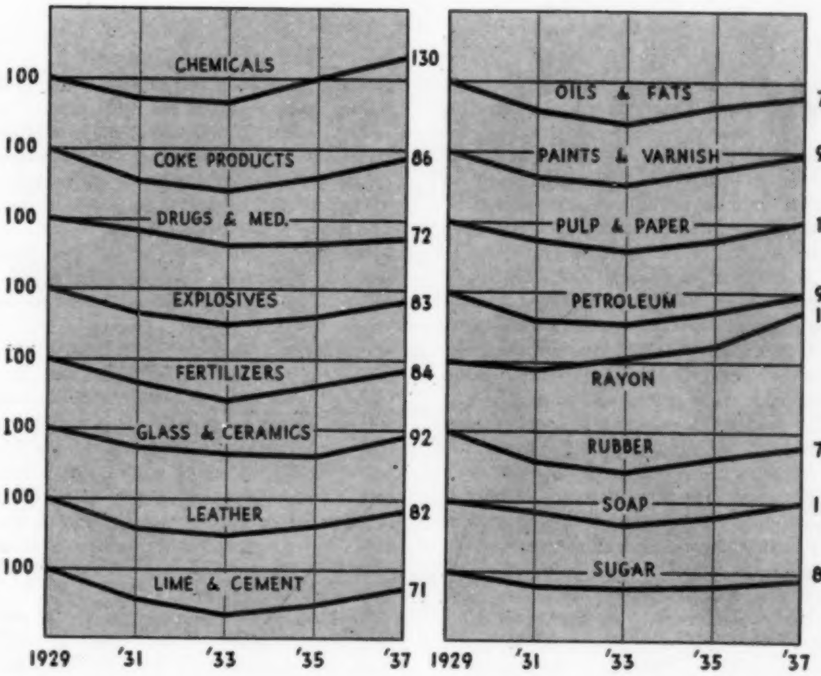
	No. of Establishments			No. of Salaried Employees			Total Salaries — $1,000		
	1937	1935	1929	1937	1935	1929	1937	1935	1929
Chemicals	3,047	2,852	2,508	30,085	26,448	32,547	71,700	61,722	83,142
Coke oven products	94	94	153	2,111	1,743	2,951	5,695	4,138	7,451
Drugs, medicines, cosmetics	1,512	1,635	2,702	12,851	12,934	10,050	29,532	30,286	27,525
Explosives and Fireworks	127	126	145	975	985	966	2,587	2,562	2,680
Fertilizers	743	670	638	3,349	3,223	4,051	6,370	6,081	9,398
Glass and ceramics	1,704	1,564	2,376	11,850	13,344	17,279	34,688	29,543	46,215
Leather Tanned	402	384	471	3,740	3,946	4,291	10,737	10,957	15,649
Lime and cement	361	342	411	3,479	3,410	6,216	8,235	8,125	16,034
Oils and Fats	1,049	1,041	1,153	5,529	5,464	6,439	12,548	11,637	15,881
Paints and Varnishes	1,124	1,082	1,063	11,995	10,914	12,888	28,522	24,472	38,034
Paper and Pulp	841	779	883	13,879	13,760	13,629	36,971	35,025	43,468
Petroleum Products	365	395	390	15,268	14,709	13,797	36,393	33,841	33,578
Rayon	33	32	29	5,172	3,607	2,278	11,579	7,482	5,769
Rubber goods	478	466	525	20,147	16,845	22,834	45,022	59,868	55,353
Soap and cleaning compounds	595	633	711	5,118	4,751	6,312	11,347	10,809	15,853
Sugar	169	182	173	3,863	3,767	3,504	8,163	7,197	7,817
Other products	1,489	1,518	1,425	9,870	8,951	13,124	22,794	21,026	34,705
Total	14,133	13,795	15,846	159,281	148,801	173,246	382,883	264,771	458,552
Total for all industry [1]	166,793	167,916	208,662	1,216,993	1,076,073	1,303,735	2,716,474	2,253,425	3,595,064
Percent in Chem. Process Ind.	8.5	8.2	7.6	13.1	13.8	13.3	14.1	16.2	12.8

[1] 1937 returns do not include data for "Railroad Repair Shops" or for "Manufactured Gas" and figures for 1935 and 1933 have been lowered accordingly.

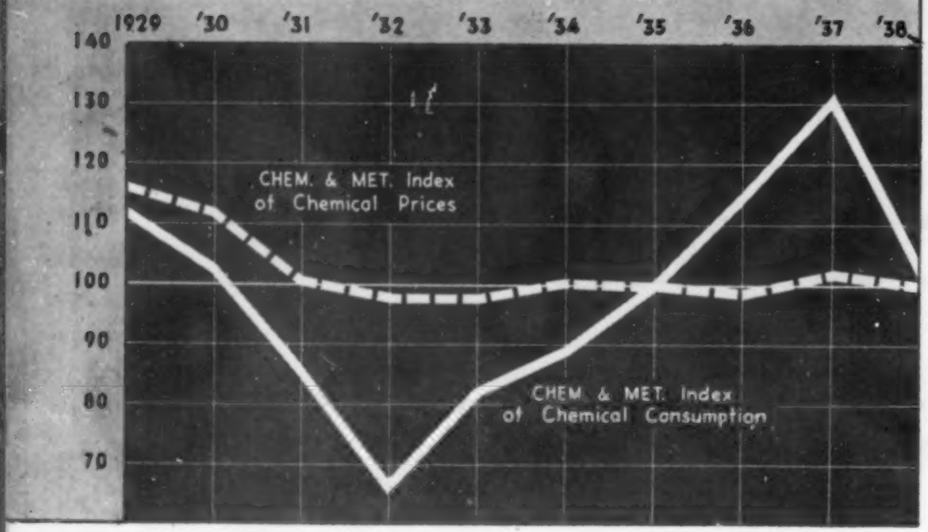
TRENDS IN PROCESS INDUSTRIES

New Census of Manufactures for 1937 shows how completely this important group has recovered from depression levels and in some instances has exceeded its 1929 peaks

14. RUBBER GOODS
    a. Rubber boots and shoes
    b. Rubber tires and inner tubes
    c. Rubber goods, not elsewhere classified
15. SOAP and Cleaning Compounds
    a. Cleaning and polishing preparations
    b. Soap
16. SUGAR
    a. Beet sugar
    b. Cane sugar
17. OTHER PRODUCTS
    a. Coated fabrics (artificial leather and oilcloth)
    b. Blacking, stains and dressings
    c. Bluing
    d. Bone black, carbon black and lampblack
    e. Candles
    f. Fuel, manufactured
    g. Glue and gelatin
    h. Graphite, ground and refined
    i. Gypsum products
    j. Impregnated wood
    k. Ink, printing
    l. Ink, writing
    m. Linoleum and asphalt-felt base floor coverings
    n. Matches
    o. Minerals and earths, ground or otherwise treated
    p. Mucilage, paste and other adhesives
    q. Paving materials, other than brick and stone
    r. Roofing, built up and roll
    s. Wall board and building insulation



No. of Wage Earners			Total Wages — $1,000			Cost of Materials, Containers, Fuel and Pwr.— $1,000			Value of Products —$1,000		
1937	1935	1929	1937	1935	1929	1937	1935	1929	1937	1935	1929
125,904	106,169	94,601	177,413	123,141	138,539	681,075	519,626	522,488	1,412,922	1,089,549	1,090,930
20,603	16,694	20,552	33,103	21,575	33,389	273,068	180,557	281,592	357,469	238,704	416,348
39,952	32,380	40,908	36,227	31,166	45,837	157,489	131,356	202,520	486,190	417,178	646,795
7,166	6,158	7,425	10,241	6,956	10,418	27,907	19,627	34,229	66,310	47,172	79,123
20,893	17,473	20,926	15,364	10,967	17,884	130,081	93,365	159,801	195,759	140,386	232,511
175,797	140,793	197,159	198,222	134,333	239,576	218,477	166,227	223,980	647,315	462,554	715,291
50,687	50,877	49,932	61,289	55,683	63,414	281,506	197,970	337,598	395,022	308,345	481,340
36,177	28,195	41,922	43,680	26,956	58,325	83,266	51,864	109,150	218,223	143,739	303,325
29,311	24,229	28,092	25,013	18,295	29,178	362,253	260,014	470,996	458,126	374,707	601,308
31,664	27,686	29,211	42,751	32,187	42,245	312,085	231,983	334,132	538,461	417,000	568,976
137,803	126,971	128,049	175,650	133,602	173,078	721,101	525,280	723,361	1,205,132	879,002	1,206,114
83,182	77,402	80,596	140,415	109,611	131,177	2,064,307	1,478,225	2,031,341	2,546,746	1,838,622	2,639,665
55,098	50,550	39,106	65,291	50,693	44,697	80,616	64,506	33,335	254,697	185,160	149,546
129,818	114,681	149,148	171,305	133,715	207,306	514,260	368,582	578,678	883,033	677,659	1,117,460
17,349	16,735	17,076	23,017	18,372	22,351	208,814	156,706	199,752	359,163	281,559	360,971
27,611	26,008	23,727	30,086	24,802	29,514	452,371	425,617	521,583	561,178	498,655	634,268
67,104	62,454	56,881	80,657	52,360	76,731	361,917	262,920	422,211	642,687	478,411	722,743
1,056,209	925,446	1,025,311	1,329,724	984,205	1,363,669	6,930,593	5,134,434	7,156,447	11,228,433	8,478,402	11,966,714
8,569,578	7,203,794	8,359,365	10,112,808	7,311,329	10,923,501	35,536,140	26,440,419	37,827,156	60,710,073	44,993,699	68,652,293
12.3	12.8	12.3	13.1	13.3	12.5	19.5	19.4	18.9	18.5	18.8	17.4



CONSUMPTION T

WHILE census data in alternate years have offered a means for measuring the progress of the chemical industry on the basis of value of products, the comparison of actual volume of output, except in the case of specified products, has not been possible. To relate variations in the rate of manufacturing operations to the changing values of the goods produced would disregard revisions in price schedules and fail to take into consideration the relatively larger growth in output of chemicals with wide spreads in unit values.

To bridge this gap in statistical service, *Chem. & Met.*, after an intensive study of industry consumption, devised an index of chemical consumption, which in normal years—that is, years when inventories at the beginning and end of the year are in balance—is practically an index of chemical production. This index was first published last September and since then has been computed for back years through 1929. The latter was a peak year for several manufacturing industries but reference to the accompanying table shows that the volume of chemical production topped the 1929 total in 1936 and reached its high point in 1937 with 1938 falling back close to the 1929 level.

The index for chemical consumption carries the dual advantage of appearing monthly and of setting forth the monthly status of the 13 major industries upon which the index is predicated.

Monthly publication reduces the time lag and projects current production trends to a point where they are of value as aids in establishing rates of manufacturing operations. Detailed indexes for the component industries furnish a basis for computing the rate of activity in the separate divisions of chemical manufacture. For instance, the alkali producer may segregate the industries which consume his products giving to each its respective weighting and the index movements of those industries from month to month can easily be translated into alkali equivalents.

In tracing the volume growth of the chemical industry from 1929 through 1937, the consumption indexes bring out strongly that this result followed developments in the pulp and paper, glass, petroleum refining, rayon, and plastics industries.

Pulp and paper growth dates back but a few years. The important stimulus came from the establishment of the Kraft paper industry in the southern states. The importance of this from a chemical standpoint may be visualized from the fact that in 1937, the capacity of domestic chlorine plants was extended to an almost uneconomic point in order to satisfy abnormal consuming requirements which resulted largely from the increased outlet in bleaching Kraft pulp. Chlorine was not the only chemical which owes its rapid expansion to the pulp and paper industry. Salt cake is another exhibit in the pulp exposition. Not only has domestic production of salt cake been increased but foreign markets have been called upon to make up the deficiency and at present this chemical holds a high ranking in the import statistics.

Repeal of prohibition and the automotive industry are the answers to the question of why consumption of chemicals has gained ground in glass making. With the repeal of prohibition, glass containers found a wider market and as the trend toward glass packaging ex-

Chem. & Met's Weighted Index for Consumption of Chemicals Based

Industry	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Fertilizer	24.95	26.40	18.53	11.64	17.78	18.91	19.47	22.57	28.93	23.72
Pulp and paper	12.07	11.46	10.71	9.34	10.80	11.15	12.39	14.31	15.96	13.70
Glass	10.60	9.31	8.00	6.03	7.71	8.21	10.58	12.45	13.61	9.00
Petroleum	10.86	10.11	9.77	8.93	9.37	9.74	10.51	11.61	12.87	12.68
Paint, varnish, and lacquer	12.84	10.40	8.62	5.96	6.80	8.54	10.35	10.77	11.33	9.47
Iron and steel	9.13	7.53	5.56	3.10	4.46	5.43	7.20	8.00	9.21	5.87
Rayon	2.92	3.07	3.65	3.29	5.23	5.09	6.29	7.01	7.97	5.82
Textiles	7.03	5.38	5.62	5.13	6.40	5.52	6.11	7.44	7.62	6.14
Coal products	8.55	7.32	5.23	3.58	4.22	4.88	5.74	7.46	9.66	5.37
Leather, glue and gelatine	3.75	3.32	3.25	3.11	3.55	3.65	3.95	4.08	4.10	3.35
Explosives	5.89	5.17	3.97	2.76	3.04	3.74	3.62	4.60	4.71	3.89
Rubber	2.53	2.02	1.58	1.57	1.86	2.10	2.17	2.58	2.56	1.86
Plastics	.79	.78	.82	.64	.78	1.09	1.62	1.97	2.28	1.30
	111.91	102.29	85.31	65.08	82.00	88.05	100.00	114.85	130.81	102.51

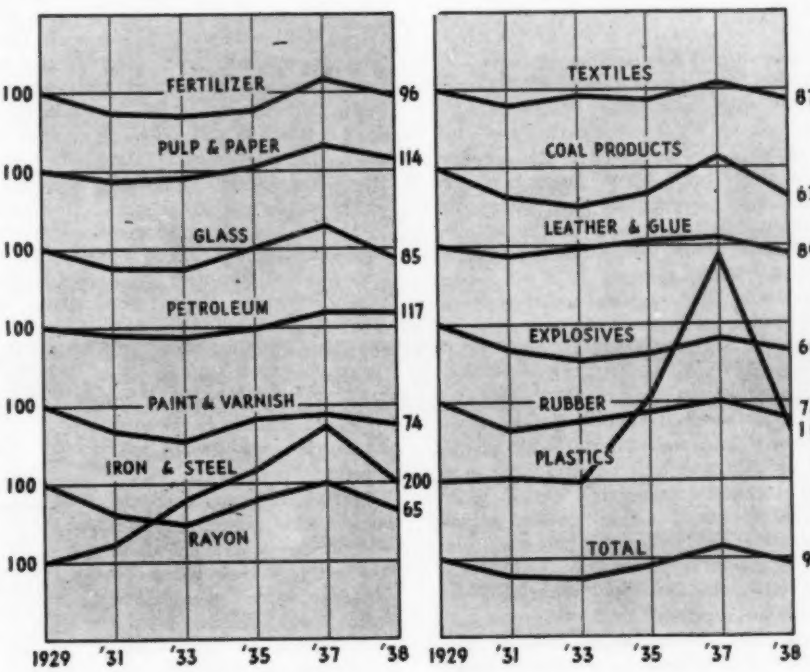
TRENDS IN PROCESS INDUSTRIES

Development of new products such as synthetic organic chemicals and the rise of new industries, notably rayon and plastics, have played an important part in widening distribution channels for chemicals

tended to other lines, the container branch made more secure its position as leader of glass-making groups. The change in automotive construction whereby plate glass has a higher proportionate use and the almost universal adoption of safety glass account for the huge gains in plate glass production in recent years. And plate glass and glass containers had much to do with broadening demand for chemicals in glass manufacture.

Back in 1929, domestic rayon producers were shaping this infant industry for an upward line of travel. By 1935 the output of 1929 had been more than doubled and the upward climb continued through 1937 which so far is the year of record production. The young industry with its phenomenal expansion has been a decided factor in widening the distribution field for chemicals.

A parallel to the rayon development is found in the field of plastics. New plastics and new uses for plastics has been an almost continuous refrain and in its realization another outlet was opened up for large-scale distribution of chemicals and related products.



on Productive Activities in Principal Consuming Industries, 1929–1938.

1938												
Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
29.87	25.04	25.39	22.39	22.61	19.38	17.55	22.35	21.99	24.94	25.83	27.34	..................Fertilizer
12.31	12.59	14.12	12.95	12.67	13.88	13.14	13.90	14.26	15.45	15.20	13.98	............Pulp and paper
7.84	7.26	8.50	8.47	8.79	8.65	8.48	9.30	9.34	10.42	10.61	10.39	....................Glass
12.78	11.51	12.51	12.49	12.95	12.25	13.03	13.23	12.80	13.04	12.66	12.84	..........Petroleum refining
7.18	7.35	9.98	11.28	11.96	11.02	9.07	10.71	10.08	9.74	8.60	6.60	..Paint, varnish, and lacquer
4.24	5.40	6.04	6.10	5.30	4.20	5.40	5.96	6.19	6.60	7.90	7.09	..............Iron and steel
4.86	4.47	4.78	4.36	4.39	4.37	5.15	5.22	7.95	7.77	8.09	8.41	....................Rayon
5.19	5.19	5.81	5.06	5.15	5.45	6.20	7.16	6.83	7.00	7.40	7.28	....................Textiles
5.50	4.96	5.39	5.12	4.77	4.17	4.55	4.95	5.43	6.27	6.39	6.85	..............Coal products
3.15	3.69	3.87	3.62	3.47	3.11	3.65	4.31	4.17	3.90	3.68	3.62	...Leather, glue and gelatine
4.05	3.59	3.42	3.35	3.63	3.71	3.38	4.04	4.44	4.69	4.30	4.15	..................Explosives
1.57	1.28	1.59	1.48	1.53	1.63	1.76	2.09	2.14	2.30	2.56	2.56	....................Rubber
.99	.96	1.17	1.16	1.11	1.10	1.30	1.44	1.50	1.62	1.60	1.66	....................Plastics
99.62	93.29	102.57	97.83	98.33	92.92	92.66	104.66	107.12	113.74	114.82	112.77	

MINERAL ACIDS AND SULPHUR

Sulphuric acid continues to be a good indicator both of general business and of chemical consumption

Where producers of sulphuric acid and the suppliers of their raw materials were duly exultant in 1937, when production of this most used of all chemicals hit hitherto unprecedented heights, 1938 saw them with sorrowful faces, wondering again whether the old worry might finally be coming true, whether finally sulphuric acid might be "on the skids." The final picture may have been gloomy, but only as the entire chemical picture was gloomy for again sulphuric acid accurately reflected the trend, its consumption having dropped some 22.5 per cent and thus corresponding almost exactly with the average decline in consumption for all chemicals. One more bit of evidence is thus added to the growing mass of statistics which prove that sulphuric acid consumption is a remarkably accurate indicator of the industrial picture.

What the actual production of sulphuric acid was during the year 1938 will never be known with complete accuracy since 1938 was not a Census year. Our estimate places the figure at 6,400,000 tons, which is about 5.3 per cent below our estimate of consumption for the year. That there should be this discrepancy is logical, since sulphuric acid stocks were large at the end of 1937 and it is reported that they have declined considerably during 1938.

What happened to acid in the principal consuming industries is interesting not only in the accurate reflection of its average, but in the individual variations. As would be expected from the relatively constant performance of the industry, the smallest decline was in petroleum refining which took some 7.4 less acid than in 1937. The trend toward decreased acid consumption in petroleum refining, which was evident some years ago, has flattened off in recent years and there is a possibility that the trend may reverse owing to the introduction of some of the new catalytic refining processes. At least one of these employs sulphuric acid as a catalyst which is recovered in part, but not wholly.

Production of phosphate fertilizers, by far the largest user of sulphuric acid, lost ground in comparison with 1937 to the extent of an estimated 16.3 per cent. This drop was due actually to the reduction in superphosphate production and not, as yet, to the influence of the electric furnace process which is still too small a factor to affect the total picture materially. Another large user, paints and pigments, which employs acid chiefly in the production of lithopone and titanium dioxide pigments, also suffered to a lesser extent than some of the other acid-using industries, decreasing its acid requirement by about 18.1 per cent. The percentage decline in rayon and cellulose film was slightly over 18 per cent, corresponding approximately to the drop in caustic soda use in that industry.

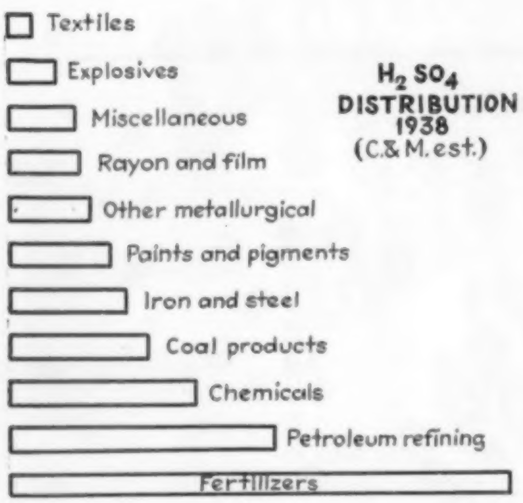
Decline in wool carbonizing in the textile industry brought down acid consumption in this field by some 19.6 per cent while an identical decline was evident in the manufacture of explosives. Production of chemicals, the third largest user of sulphuric acid, lost to an extent indicated at 22.6 per cent. A full 25 per cent decrease is believed to have taken place in miscellaneous uses, while a decrease of 32 per cent portrays the situation in acid application in the coal products field. Decline in iron and steel production, particularly in those branches of the industry using the most acid for pickling purposes, was heavy and the decrease in acid consumption is estimated at 41.2 per cent. An even larger decline of 43.6 per cent is indicated in other metallurgical uses.

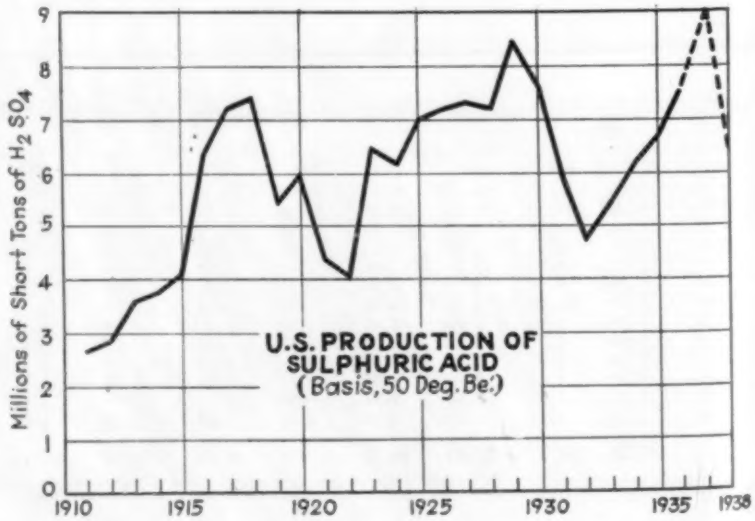
It is with a certain amount of trepidation that we call attention to our estimates for total sulphuric acid production in 1937, in comparison with the 7,818,643 short tons of acid (50 deg. Bé. equivalent) reported by the Census. A year ago we pointed to the fact that estimates based on raw materials indicated that possibly as much as 9,500,000 tons of acid (50 deg. basis) had been produced, but that it was known that sulphur stock

Estimated Distribution of Sulphuric Acid Consumed in the United States

(Basis, 50 deg. Bé.)

Consuming Industries	1936 Short Tons (Revised)	1937 Short Tons (Revised)	1938 Short Tons
Fertilizers	1,987,000	2,510,000	2,100,000
Petroleum refining	1,100,000	1,210,000	1,120,000
Chemicals	955,000	1,020,000	790,000
Coal products	770,000	860,000	585,000
Iron and steel	770,000	850,000	500,000
Other metallurgical	560,000	620,000	350,000
Paints and pigments	450,000	525,000	430,000
Explosives	222,000	230,000	185,000
Rayon and cellulose film	330,000	380,000	310,000
Textiles	108,000	112,000	90,000
Miscellaneous	380,000	400,000	300,000
Totals	7,632,000	8,717,000	6,760,000





piles in the hands of consumers had increased during the latter part of 1937 and that a reasonable estimate for the amount of acid actually produced was 8,900,000 tons. Now, having recalculated the raw materials which went into sulphuric acid production in 1937 on the basis of more recent and more accurate figures, it appears that the total production could not have been less than 9,000,000 tons. The only figures not known with a quite high degree of accuracy in this estimate are the amounts of sulphur employed for uses other than acid production and the amounts of sulphur and pyrites accumulated but not used by the acid plants during the year. This large production, incidentally checks quite closely with informed trade opinions.

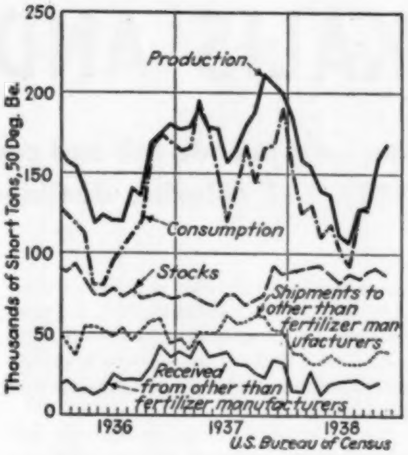
Assuming for the present, therefore, that 1937 production was actually at this high level, the decline in acid making from 1937 to 1938 was of the order of 29 per cent.

Acid Raw Materials

Sulphur production at the mines was in the neighborhood of 2,375,000 long tons in 1938, while domestic shipments have been estimated at about 1,059,000 tons and exports at 576,000 tons. This indicates an increase in producers' stocks at the mines of about 740,000 long tons. Comparable figures for 1937 were: production, 2,741,970 long tons; domestic shipments, 1,791,512 tons; exports, 675,000 tons; and an apparent increase in stocks at the mines of 275,458 long tons. With total stocks at the mines about 3,400,000 tons at the end of 1937, the total at the close of 1938 was evidently about 4,140,000 long tons. Where in 1937 we estimated that 564,000 long tons of sulphur was used for non-acid purposes, leaving 1,227,000 tons shipped to acid makers, in 1938 the non-acid uses are believed to have totaled about 350,000 long tons, leaving 709,000 tons available for making acid from the sulphur shipped.

An indefinite quantity, possibly 50,000 tons, was also withdrawn from consumers' sulphur stocks and converted into acid in 1938. On this basis, 3,940,000 short tons of acid (50 deg. basis) would have been produced from sulphur alone.

In addition, acid was produced from both imported and domestic pyrites and from waste gas at smelters. Imports of pyrites, running about 48 per cent sulphur, are estimated at 350,000 long tons on the basis of 11 months' figures, while it is probable that acid-makers took about the same tonnage of domestic pyrites, averaging about 40 per cent sulphur. Together, the two types of pyrites would provide about 1,600,000 short tons of acid. Adding our estimate of 860,000 short tons of byproduct acid from smelters, we arrive at a total production of 6,400,000 short tons of acid (50 deg. basis). Additional production was made from hydrogen sulphide at a number of



Sulphuric acid in fertilizer plants, 1936-8

oil refineries, both in 1937 and in 1938, but the quantity is uncertain and has been disregarded in this compilation. Eventual capacity from this source has been estimated by Egloff at 100,000 tons annually.

In comparison with the 1938 figures and in support of our 1937 estimates, the detailed calculations of acid sources in the latter year are given below: The 1,227,000 long tons of sulphur shown above to have been available for acid was undoubtedly used only in part. Deducting the 135,000 long tons which sulphur producers estimate went to increase users' stocks, we arrive at 1,092,000 tons burned, producing about 5,690,000 short tons of acid. Pyrites imports (48 per cent sulphur) amounted to 524,430 long tons, and domestic pyrites production (40 per cent sulphur) to 584,166 long tons, and this total quantity would have produced 2,520,000 tons of acid. Deducting an arbitrary 10 per cent for increase in pyrites stocks leaves 2,260,000 tons of acid which, added to the 1,050,000 tons produced at smelters according to the U. S. Bureau of Mines (833,994 tons 60 deg. Bé.), and the acid from sulphur, gives a grand total of 9,000,000 short tons (50 deg. basis).

No new trends likely to have far-reaching effects were evident during 1938, nor do we know of any new acid plant construction being started. Several plants on which construction was commenced in 1937 were completed, reaching a reported total of some 305 tons per day capacity (100 per cent basis), including a small plant in Puerto Rico. Two new hydrogen sulphide recovery plants were said to be under construction by one of the large oil companies, one a Koppers phenolate process and the other a Girdler process plant. Acid plants for the eventual utilization of this hydrogen sulphide were said to be contemplated but not contracted for.

(Please turn to page 125)

MOST RECENT CENSUS DATA

BLACKS	1937	1935
Aggregate, pounds	551,487,051	389,573,266
Value	$19,578,681	$15,453,513
Made as secondary products in other industries (included above), value	$1,023,957	$803,258
Bone black, pounds	35,571,397	32,922,190
Value	$1,717,160	$1,312,972
Carbon black, pounds	510,606,343	352,749,000
Value	$17,389,000	$13,755,000
Lampblack, pounds	5,309,311	3,902,076
Value	$472,521	$385,541
CEMENT		
Total, barrels	118,075,351	77,747,634
Value	$183,201,048	$120,417,129
Portland, barrels	116,174,708	76,741,570
Natural, puzzelan and masonry, barrels	1,900,643	1,006,064
CHEMICALS NOT ELSEWHERE CLASSIFIED		
Chemicals, miscellaneous		
Total value	$126,078,309	$102,363,734
Acetates, total value	$20,587,200	$13,217,439
Aluminum, tons (basis 20%)	[1]	175
Value	[1]	$30,285
Ammonium, pounds	46,435	[1]
Value	$8,342	[1]
Amyl, gallons	1,521,997	1,025,789
Value	$1,188,779	$789,293
Butyl, gallons	9,316,128	5,631,056
Value	$5,084,985	$3,686,689
Calcium, tons (basis 80%)	22,517	25,851
Value	$726,655	$825,522
Ethyl, gallons	6,946,081	5,563,199
Value	$2,919,201	$2,679,195
Chromium, pounds (basis 8½ to 12% Cr_2O_3)	811,587	630,023
Value	$37,459	$35,171
Lead, pounds	1,957,811	3,360,067
Value	$206,888	$252,799
Sodium, pounds	6,169,383	[1]
Value	$244,003	[1]
Other acetates, value	[2] $10,170,888	$4,918,485
Acetone, pounds	84,369,475	68,921,870
Value	$2,845,436	$2,642,149
Acids, total value	$87,657,748	$65,389,561
Acetic (basis 100%) [3]		
Pounds	131,644,596	101,500,662
Value	$6,607,187	$5,455,362
Boric (boracic)		
Pounds	40,524,000	28,738,000
Value	$1,545,304	$1,245,874
Chromic, pounds	8,997,337	6,723,304
Value	$1,260,477	$887,842
Citric (basis 100%)		
Pounds	18,138,263	10,493,068
Value	$4,118,513	$2,768,377
Hydrochloric, total production (basis 100%) tons	121,473	87,090
Consumed, where made, tons	50,307	32,201
For sale, by process		
Tons	71,166	54,889
Value	$3,987,974	$3,048,159
From salt, tons	53,027	47,098
Value	$3,048,182	$2,656,028
From chlorine, by-product and other, tons	18,139	7,791
Value	$939,792	$392,131
Hydrofluoric (basis 100%)		
Pounds	4,395,696	2,993,273
Value	$701,314	$471,327
Mixed (sulphuric-nitric)		
Tons	54,432	46,074
Value	$2,466,864	$2,105,231
Nitric, total production (basis 100%) tons	175,860	96,109
Consumed where made, tons	140,450	71,609
For sale, tons	35,410	24,500
Value	$3,052,576	$2,142,817
Oleic, pounds	38,086,766	43,763,371
Value	$3,604,790	$3,273,421
Oxalic, pounds	10,197,652	8,883,521
Value	$1,086,878	$945,215
Phosphoric (basis 50% H_3PO_4), pounds	135,144,840	45,385,991
Value	$2,788,600	$1,333,702
Pyrogallic, pounds	118,669	86,516
Value	$138,326	$115,802
Stearic, pounds	31,888,647	27,438,289
Value	$3,656,422	$2,776,935
Sulphuric [4]		
Total production (basis 50° Baume), tons	7,818,643	6,432,127
Consumed where made, tons	2,100,051	1,943,979
For sale, tons	5,718,592	4,488,148
Value	$42,197,855	$31,907,994
Production by process		
Contact		
Number of establishments	62	65
Total production, tons	3,651,028	3,431,427
Consumed where made, tons	664,608	834,534
For sale, tons	2,986,420	2,596,893
Value	$23,559,427	$19,457,633
Chamber		
Number of establishments	100	101
Total production, tons	4,167,615	3,000,700
Consumed where made, tons	1,435,443	1,109,445
For sale, tons	2,732,172	1,891,255
Value	$18,638,428	$12,450,361

(Continued next page)

ALKALIS AND CHLORINE

Business in soda ash and caustic was considerably below 1937, but chlorine declined little

With the general business level of the chemical industries slightly more than 22 per cent below 1937, it is not surprising that the high production and sales levels of the former year could not be matched in 1938 by the manufacturers of soda ash and caustic soda. In comparison with the total soda ash production of 3,037,421 tons reported by the Census for 1937, 1938 production was estimated at 2,500,000 tons, a decrease of 17.7 per cent. This compares with the production of 2,778,000 tons which we estimated as production in 1936 and the Census figure of 2,508,859 tons reported for 1935. 1929 production of 2,682,216 tons has been exceeded twice, in both 1936 and 1937. 1938 production, however, fell below the big boom year by some 6.8 per cent. The total production which we estimate for 1938 included a probable 100,000 tons of natural soda production, although this figure may be somewhat too high owing to the fact that the plant of one producer was closed down for a considerable part of the year. According to the Census in 1937, the total production of natural plus electrolytic soda was 118,753 tons, of which in the neighborhood of 110,000 tons was natural production.

No capacity was added to the soda ash plants of the country during 1938, although about 150,000 tons per year capacity was added during the preceding year. Thus, our estimate of 3,500,000 tons total yearly capacity, as given for 1937, remains at the present. Of this total, probably about 140,000 tons represent the capacity of the natural soda industry.

Production of Caustic Soda in the United States
(Short Tons)

Year*	Lime-Soda	Electrolytic	Total
1921	163,044	75,547	238,591
1923	314,195	122,424	436,619
1925	355,783	141,478	497,261
1927	387,235	186,182	573,417
1929	524,965	236,807	761,792
1931	455,832	203,057	658,887
1933	439,363	247,620	686,983
1935	436,980	322,401	759,381
1937 (revised)	488,807	472,784	961,591
1938 (estimated)	410,000	420,000	830,000

* Figures for 1921–1937 are from the U. S. Bureau of the Census. Electrolytic caustic soda figures do not include that made and consumed at wood-pulp mills, estimated at about 30,000 tons in 1927 and 1929, at about 24,000 tons in 1931, 21,000 tons in 1933, 20,000 tons in 1934, 17,000 tons in 1935, 19,000 tons in 1936 and 1937, and 16,000 tons in 1938.

Soda Sales Trend

Soda ash sales declined to a slightly greater extent than production. From the estimated record sales level of 2,287,000 tons in 1937, the figure declined some 19.6 per cent to an estimated total for soda ash sales of 1,837,000 tons in 1938.

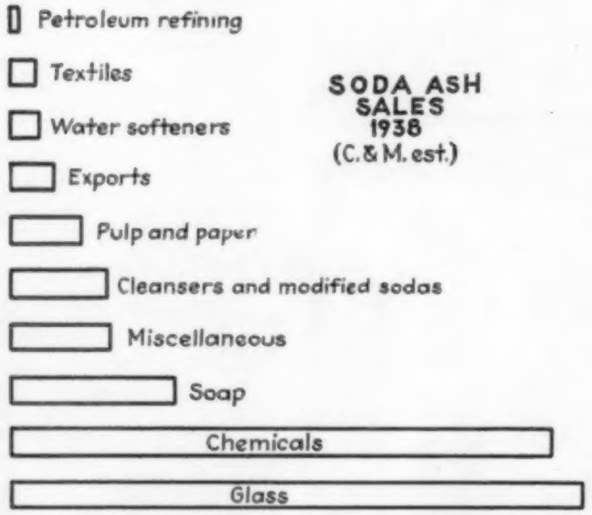
Every important consuming outlet for soda ash showed a reduction in ash consumption as compared with 1937. With the soap industry operating, as traditionally, on a substantially even keel, the loss in ash consumption was insignificant, only about 0.5 per cent. Petroleum refining, which also operated with very little decrease in activity, showed a decline in ash consumption of 4.2 per cent. Exports

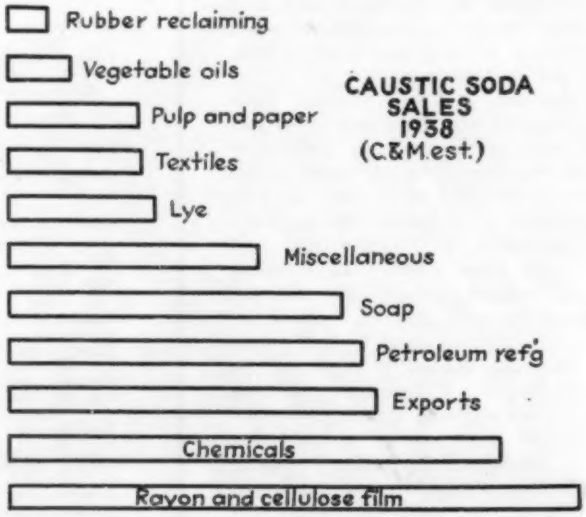
Estimated Distribution of Soda Ash Sales in the United States

Consuming Industries	1936 Short Tons (Revised)	1937 Short Tons (Revised)	1938 Short Tons
Glass	780,000	860,000	630,000
Soap	184,000	186,000	185,000
Chemicals	640,000	700,000	595,000
Cleansers and modified sodas	130,000	140,000	110,000
Pulp and paper	90,000	108,000	80,000
Water softeners	38,000	38,000	33,000
Petroleum refining	11,500	12,000	11,500
Textiles	44,000	38,000	30,000
Exports	44,000	55,000	50,000
Miscellaneous	120,500	150,000	112,500
Totals	2,082,000	2,287,000	1,837,000

Estimated Distribution of Caustic Soda Sales in the United States

Consuming Industries	1936 Short Tons (Revised)	1937 Short Tons (Revised)	1938 Short Tons
Soap	90,000	92,000	92,000
Chemicals	135,000	158,000	134,000
Petroleum refining	88,000	97,000	96,000
Rayon and cellulose film	170,000	186,000	155,000
Lye	45,000	48,000	40,000
Textiles	43,000	44,000	36,000
Rubber reclaiming	14,000	16,000	11,000
Vegetable oils	14,500	15,500	17,000
Pulp and paper	43,000	48,000	35,000
Exports	77,000	102,000	100,000
Miscellaneous	73,500	75,500	68,000
Totals	793,000	882,000	784,000



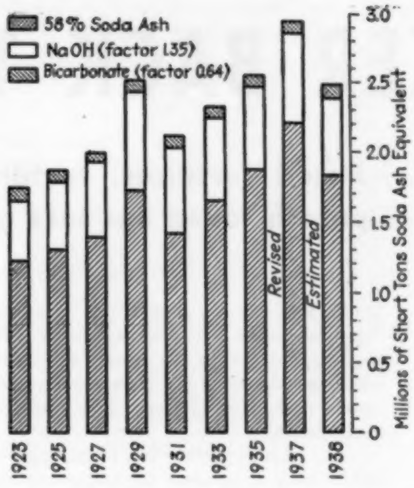


fell some 9.1 per cent while the reduction in water softeners amounted to about 13.1 per cent. The total reduction in usage of soda ash in the manufacture of chemicals was estimated at only 15.0 per cent, but this does not give a true picture of most of the field in that a large soda ash use, the making of synthetic sodium nitrate, declined very little and took only about 5,000 tons less ash than usual. The decline in the remainder of the chemical field is believed to be somewhat in excess of 20 per cent.

Wool, the principal textile consumer of soda ash, lost ground during the year slightly less than 20 per cent while the total usage of soda ash in the textile field is believed to be in the neighborhood of 21.1 per cent. A similar decline of 21.4 per cent is estimated in the field of cleansers and modified sodas and about 24.7 per cent in miscellaneous uses for soda ash. With the large drop in paperboard manufacture, the pulp and paper field decreased its soda ash usage by approximately 26 per cent, while the largest decline of all, in the glass industry, accounted for a 26.8 per cent drop from 1937. This large decline was shared by the entire glass industry, although the loss was most severe in flat glass manufacture.

Caustic Soda and Chlorine

In our reviews in the last several years we have called attention to the fact that chlorine demand was growing out of proportion to the growth in caustic soda requirements and that on this account the industry has been anxiously investigating means for producing chlorine without caustic soda. Calculating from the Census figures for 1933, approximately 211,000 tons of chlorine was produced coincident with electrolytic caustic soda production and about 5–6,000 tons with caustic potash. This accounted for practically the entire chlorine production shown by the Census for that year. A similar comparison for later years indicates an increasing discrepancy between the chlorine reported by the Census and the chlorine equivalent of the caustic soda and potash produced. This discrepancy has been made up by production coincident with metallic sodium, a small amount of electrolytic sodium carbonate, and by the process being operated at Hopewell in which nitric acid and salt react to produce sodium nitrate and chlorine. This latter process produced only a small amount of chlorine prior to 1937. During that year the actual production is unknown, but it may have amounted to 2–3,000 tons. During 1938 this production is believed to have increased slightly. According to a public report of the Federal Power Commission, the capacity of this plant will be in the neighborhood of 25 tons of chlorine and 60 tons of sodium nitrate per day. In all, during 1938, the production of chlorine in connection with caustic potash, metallic sodium and the sodium nitrate process just mentioned amounted to an estimated



Production for sale of principal ammonia-soda products (Basis, 58 per cent soda ash)

80,000 tons. In addition, it is estimated that approximately 340,000 tons of chlorine was produced coincident with the production of 420,000 tons of electrolytic caustic soda. In addition, some 410,000 tons of caustic soda was produced by the lime-soda process, giving a total of 830,000 tons of caustic soda produced during the year. By comparison, in 1937, according to the Census, the production of electrolytic caustic was 472,784 tons, of lime-soda caustic, 488,807 tons and the total, 961,591 tons. Similarly, 1937 production of chlorine, according to the Census, amounted to 446,261 tons, compared with an estimated 440,000 tons in 1938. The decline in caustic soda production from 1937 to 1938 was 13.7 per cent.

It was not until about 1932 that the increasing chlorine demand became so acute as to alter the normal ratio of about 30 per cent of caustic production produced by the electrolytic method. In 1933 the ratio rose to 36 per cent, in 1935 to 42 per cent and in 1937 to 49 per cent. 1938 represents the first year in which electrotlytic caustic production was larger than that by the lime-soda method. To an increasing extent in recent years, lime-soda manufacturers have made their bid for the chlorine market by installing electrolytic equipment which has displaced a part of their lima-soda production.

Among the industries using caustic soda, a decidedly mixed consumption trend was evident during 1938. There was actually a small estimated increase in consumption of 9.7 per cent in the field of vegetable oils, owing to the abnormally large cottonseed oil production of the year. The change in soap production was so small as to be considered negligible. A decline of about 1 per cent was registered in the case of petroleum refining,

(Please turn to page 128)

MOST RECENT CENSUS DATA

CHEMICALS, Cont'd	1937	1935
Tannic (basis 100%)		
Pounds	1,015,914	724,552
Value	$381,847	$304,728
Tartaric, pounds	10,642,838	6,887,121
Value	$2,484,625	$1,609,027
Other acids, value	$7,578,196	$4,997,748
Alcohols		
Methyl, synthetic, gal	[5] 33,374,015	13,359,247
Value	$9,108,363	$3,611,382
Amyl, including refined fused oil, pounds	[1]	5,160,604
Value	[1]	$568,111
Butyl, pounds	79,933,577	35,877,675
Value	$5,866,588	$2,601,983
Ethyl and other alcohols, Value [6]	$37,313,508	$36,299,499
Ammonia, anhydrous		
Pounds [7]	223,040,588	138,778,725
Value	$8,867,638	$5,679,399
Ammonia, aqua and liquor [8]		
Pounds (NH_3 content)	25,461,214	23,915,726
Value	$1,310,227	$1,235,479
Bicarbonates and carbonates	$43,088,703	$36,513,605
Sodium bicarbonate, refined		
Tons (basis 100%)	142,161	136,556
Value	$3,606,271	$3,658,321
Bismuth, subcarbonate		
Pounds	247,609	231,432
Value	$313,426	$364,265
Copper carbonate (52% Cu),		
Pounds	811,163	638,425
Value	$121,276	$89,536
Soda ash, total production		
Tons	3,037,421	2,508,859
Consumed where made, tons	713,662	637,224
By process:		
Ammonia soda, tons	2,205,006	1,776,470
Value	$32,306,416	$27,212,035
Natural and electrolytic soda, tons	118,753	[9] 95,165
Value	$1,462,354	$1,212,715
Calcium carbonate (precipitated chalk) tons	71,236	33,971
Value	$1,667,780	$859,649
Magnesium carbonate, precipitated, tons	6,505	7,301
Value	$788,215	$877,741
Sal soda, tons	33,064	39,439
Value	$768,659	$1,021,308
Other bocarbonates and carbonates, value	[10] $2,054,306	$1,218,035
Bismuth subgallate		
Pounds	40,861	24,328
Value	$55,270	$38,686

	1937	1935
Bromides, value	$7,057,218	$4,963,608
Calcium carbide, tons	193,045	147,092
Value	$9,844,245	$6,234,380
Bleaching powder [11]		
Tons (basis 35–37%)	45,908	39,561
Value	$937,197	$909,071
Carbon, activated, tons	10,655	11,477
Value	$1,443,936	$925,634
Carbon bisulphide, pounds	155,237,735	117,757,762
Value	$4,753,748	$3,384,851
Carbon tetrachloride		
Pounds	78,708,690	51,970,367
Value	$3,067,611	$2,149,877
Chlorates, value	$619,145	$410,499
Chlorides, total value	$19,783,203	$16,945,748
Aluminum (anhydrous, crystal and liquid) tons	4,034	2,339
Value	$623,639	$397,295
Calcium [12]		
Solid, tons (basis 75%)	4,882	7,526
Value	$85,556	$108,548
Flake, tons (basis 75%)	223,641	197,948
Value	$3,753,744	$3,205,727
Liquid, tons (basis 75%)	35,089	21,527
Value	$341,724	$314,613
Iron — ferric and ferrous		
Pounds (basis 100%)	13,577,650	11,318,416
Value	$373,579	$291,875
Mercury — mercuric and mercurous, pounds	520,216	478,486
Value	$603,574	$428,402
Tin — stannic, pounds	[13]	15,640,763
Value	[13]	$3,976,487
Tin — stannous, pounds	460,841	477,229
Value	$180,499	$174,811
Ammonium (sal ammoniac)		
Pounds	39,599,247	34,864,681
Value	$1,821,494	$1,583,613
Copper, pounds	95,452	77,290
Value	$19,640	$9,717
Gold, ounces	2,903	1,102
Value	$57,995	$24,404
Methyl, pounds	3,389,125	2,083,974
Value	$1,043,195	$688,927
Other chlorides, value	[14] $10,878,564	$5,741,329
Chloroform, pounds	[1]	1,799,437
Value	[1]	$324,091
Chromates and bichromates,		
Total value	$6,464,596	$5,220,904
Sodium, tons	48,697	42,325
Value	$5,925,611	$4,762,728
Potassium, pounds	4,717,202	4,491,316
Value	$386,369	$359,366
Other chromates and bichromates, value	[15] $152,616	$107,800

(Continued next page)

FERTILIZER BACK TO NORMAL

Mixed fertilizer, fertilizer phosphate, nitrogen and potash found business good, but unexciting

FERTILIZER activities of production, marketing and use were what one might call "normal" in 1938. Following the all-time record year of 1937, the business of the year just closed looks somewhat small; but it was in fact the greatest year of activity since 1930, except for the record year of 1937.

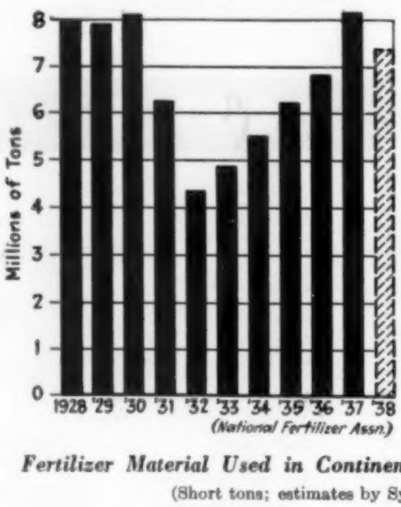
It is estimated that the actual consumption of mixed fertilizers and fertilizer materials during the past year was about 7.3 million tons, as contrasted with about 8.1 million tons in the record year. The decline of 10 per cent actually experienced was only about one-half of that generally forecast a year ago. The improvement in business conditions during the latter months of 1938 was so pronounced that in one or two of these months the tax tag sales were actually somewhat greater than the year before. This implies that both the fertilizer year ending next June and the calendar year 1939 may be a little better than their predecessors, but it is doubtful whether 1937 will be quite equalled in 1939.

Farm economics and farm habits continue to govern both the prosperity and the technology of this industry. Following a year of high agricultural cash income there is sure to be a year of generous fertilizer spending. However, to some extent this trend may be offset if fertilizer materials and mixed fertilizers should again advance in price, as some in the industry are forecasting. Perhaps the best index of relationships is that recently charted by the American Potash Institute showing the relationship between cash farm income and fertilizer expenditure.

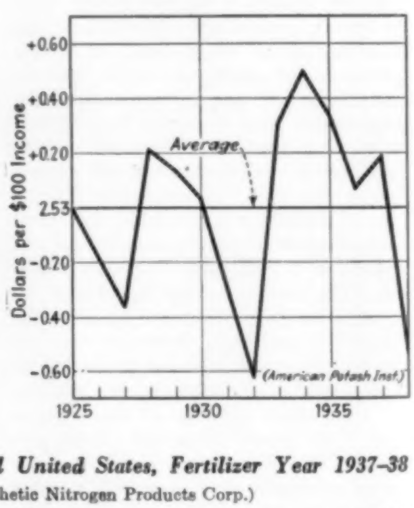
Until recently cotton has been regarded as the crop of greatest importance to the fertilizer men. Perhaps it still so qualifies; but if so, it is by an extremely narrow margin because truck crops, corn and tobacco are now in some areas more important users of fertilizer. This shift is largely the result of declining cotton acreage cultivated. Actually, the use of fertilizer per acre of cotton grown has continued to increase even during 1938. It is only because the fertilizer industry and the fertilizer material groups, notably the American Potash Institute, have vigorously striven for increased fertilizer consumption on other crops that the total sales of fertilizers have been so well maintained. Fortunately, the crops on which fertilizer consumption is increasing are those of more stable nature than are either cotton or corn.

Continued efforts of fertilizer makers and agronomists favor both fewer fertilizer formulas, and the use of higher concentration materials. Apparently the uptrend in percentage of plant food in mixed fertilizers continued, but the gain last year was undoubtedly only a small fraction of 1 per cent. Perhaps the most important influence in this direction was the T.V.A. stimulus for "super-concentration."

United States fertilizer consumption from 1928 to 1938



Fertilizer expenditures per $100 cash farm income



Estimate of World Fertilizer Consumption, 1936[1]

(Metric tons)

	Tons of Product	Tons of Plant Food
Nitrogen		
Ammonium sulphate[2]	5,257,000	1,083,000
Chile nitrate	1,403,000	221,000
Calcium cyanamide	1,340,000	268,000
Other synthetic N fertilizers	4,013,000	642,000
Total tons	12,013,000	2,214,000
Phosphoric Acid		
Superphosphate	15,706,000	2,669,000
Basic slag	5,000,000	800,000
Ground phosphate	1,600,000	285,000
Bones and organics	350,000	105,000
Guano	250,000	32,500
Treated phosphates	250,000	71,250
Concentrates	303,000	90,000
Total tons	22,855,000	4,052,750
Potash		
All products[3]	7,061,500	2,295,000
Total tons	41,929,500	8,561,750
Nitrogenous fertilizers, per cent.	28.65	25.86
Phosphatic fertilizers, per cent.	54.51	47.34
Potassic fertilizers, per cent	16.84	26.80

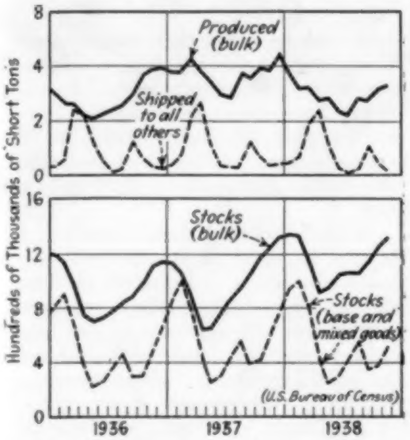
[1] Presented by A. N. Gray of Int'l Superphosphate Mfrs. Assn. at recent Int'l Fertilizer Congress in Rome.
[2] Includes ammonia for mixed fertilizers.
[3] Agriculture takes 90 per cent of total potash consum tion.

Fertilizer Material Used in Continental United States, Fertilizer Year 1937–38

(Short tons; estimates by Synthetic Nitrogen Products Corp.)

	Total Material	Plant Food — N	Plant Food — P_2O_5	Plant Food — K_2O	Applied* Directly
Sulphate of ammonia	504,000	103,800	....	....	135,000
Nitrate of soda	695,000	111,500	....	....	615,000
Byproduct ammonia liquor	35,000	7,500	....	....	....
Synthetic N-containing solutions	83,000	37,500	....	....	3,000
Cyanamide	108,000	23,200	....	....	58,000
Calcium nitrate and urea fertilizers	120,000	22,800	....	....	64,000
Imported complete fertilizers	8,000	1,100	1,400	1,100	....
Ammonium phosphates	54,000	7,000	20,000	....	18,000
Nitrate of potash, nitrate of soda-potash	37,000	5,300	....	7,400	17,000
Other potash materials	630,000	....	....	312,600	60,000
Cottonseed meal	220,000	13,200	5,100	3,700	150,000
Other natural organics	470,000	26,500	22,500	4,600	50,000
Bulk superphosphate	3,285,000	....	616,100	....	†900,000
Basic slag	50,000	....	6,500	....	50,000
Bones, bone meal	90,000	1,800	20,500	....	40,000
Ground phosphate rock	140,000	....	5,600	....	90,000
Sulphuric acid (for acidulating certain organics)	20,000	....	....	....	....
Wood, beet root ashes	4,000	....	....	200	....
Dolomite, limestone	350,000	....	....	....	....
Filler	697,000	....	....	....	....
Total tonnage	7,600,000	361,200	697,700	329,600	2,250,000

* Materials not used in mixed fertilizers; includes materials used in home-made mixtures.
† Includes about 15,000 tons of "basic lime phosphate." Does not include about 25,000 tons of triple super distributed by T.V.A. and A.A.A.



Production, shipments and stocks of superphosphate in the United States

During 1938, apparently for the first time, there was a definite effort made by the industry to have the recommended formulas selected in one state conform a little more closely to the formulas recommended for other nearby states. This coordination of state efforts cannot go forward very rapidly because of differences in soil types and in cropping habits, but the movement appears an important one in its long-time significance, as it will tend to reduce the overall cost for average manufacture by reducing the number of types of goods offered for sale.

The tendency of the industry to abandon rail movement from the fertilizer plant to the farm made notable further progress during the last two years. National Fertilizer Association estimates that as recently as 1931 only 10.8 per cent of out-bound fertilizer traffic moved by truck. By 1937 there was more than 46 per cent so moving and now apparently well over one-half of the shipments are by truck rather than by rail.

Fertilizer Phosphates

Notable in the phosphate picture last year was the further improvement in efficiency of production of marketable grades of phosphate from medium- or low-grade rock. The outstanding advantages of modern beneficiation were spotlighted by a special report made during the year by the W.P.A., which demonstrated tremendous improvement in efficiency of production per man hour and in recovery from low-grade raw material.

The industry's troubles with T.V.A. last year were reduced to the status of a minor irritant. The industry still complains of the threatened competition of the Valley agency, but its most important complaint seems to be rightly directed against the A.A.A., as a customer of T.V.A., rather than against T.V.A. itself. This is the way the situation has developed:

Triple-A has been seeking to advance the cause of concentrated fertilizers by using high strength superphosphate containing from 45 to 48 per cent P_2O_5. Last year 66,000 tons of that material was given to farmers for cooperating in the soil development program. During 1939 it is expected that 140,000 tons will be used, about 45,000 tons purchased from T.V.A. and the balance from commercial manufacturers. The threat that T.V.A. would increase its productive capacity, if necessary, to make this larger quantity has been met by increased activity of the industry itself. Offerings on request for bids have been more than enough to permit the Department of Agriculture to purchase all that it requires from commercial producers.

Phosphate Rock Production and Consumption By Continents [1]

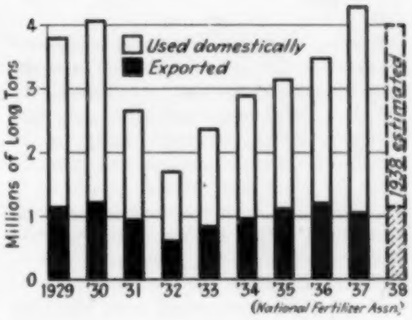
(Metric tons; production in Roman type, consumption in italic)

	1908–13 Average	1925–29 Average	1935–37 Average
North America [2]	2,879,000	3,480,000	3,506,000
	1,370,000	*2,557,000*	*2,400,000*
Europe	577,000	330,000	2,400,000
	4,005,000	*5,651,000*	*6,500,000*
Africa	2,044,000	4,894,000	4,051,000
	40,000	*160,000*	*250,000*
Asia	7,000	102,000	133,000
	225,000	*700,000*	*1,100,000*
Islands [3]	546,000	960,000	1,510,000
	110,000	*682,000*	*850,000*
Totals	6,053,000	9,766,000	11,600,000
	5,050,000	*9,750,000*	*11,100,000*

[1] From U. S. Bureau of Mines; partly estimated but based mainly on statistics of Int'l Superphosphate Mfrs. Assn.

[2] Curacao included with "Islands."

[3] Production mainly in Oceania but consumption chiefly in Australia and New Zealand.



Production and exports of phosphate rock

Just at this point comes the difficulty. Last year a little over one-half of the total tonnage of this concentrated material was used in Kentucky and the commercial sales of fertilizer in that state were cut 40 or 45 per cent below normal. The industry rightly complains that an area using one-fortieth of all the fertilizer of the country should hardly have had one-half of this one grade.

The T.V.A. technical work on phosphates continued along lines noted a year ago. The controversies among the three directors had little effect on the phosphate fertilizer program. The outstand-

MOST RECENT CENSUS DATA

MISC. CHEMICALS, Cont'd.	1937	1935
Citral, pounds	17,175	11,340
Value	$28,386	$21,698
Citrates, total value	$947,701	$1,356,874
Iron-ammonium, pounds	340,863	304,902
Value	$108,413	$123,643
Potassium, pounds	200,573	174,501
Value	$72,217	$65,761
Iron, pounds	[1]	5,785
Value	[1]	$4,223
Sodium, pounds	3,064,445	[13]
Value	$651,924	$1,163,247
Other citrates, value	$115,147	
Coal-tar products		
Total value [16]	$159,518,470	$120,581,844
Crudes [17]	$29,470,712	$19,173,099
Intermediates	$37,139,727	$29 300,324
Finished products	$92,908,031	$72,048,421
Cyanides, total value	$4,883,777	$4,429,529
Copper, pounds	738,683	473,492
Value	$264,244	$169,557
Silver, ounces	[1]	130,073
Value	[1]	$77,899
Other cyanides, value [18]	$4,619,533	$4,182,073
Ester gum, pounds	25,589,993	21,372,890
Value	$2,212,945	$1,481,880
Ether (ethyl) pounds	13,097,484	7,915,299
Value	$1,651,846	$1,305,450
Ferro-alloys, electric-furnace, tons (2,240 lbs.)	352,318	216,627
Value	$45,295,278	$23,489,764
Fluorides, value	$5,133,706	$1,969,219
Geraniol, pounds	166,942	111,096
Value	$126,816	$147,767
Glycerin, crude, pounds	24,180,767	24,042,800
Value	$3,592,537	$2,366,481
Glycerin, dynamic grade [19]		
Pounds	43,586,391	
Value	$7,822,600	118,726,871
Glycerin, chemically pure [19]		$12,973,082
Pounds	78,813,063	
Value	$13,459,921	
Glycerophosphates, value	$227,743	$165,955
Hydroxides, total value	$34,561,653	$30,295,190
Potassium (caustic)		
Tons (basis 100%)	10,839	9,518
Value	$1,437,509	$1,260,031
Sodium (caustic) total productions, tons [20]	961,501	759,381
Consumed where made, tons	71,315	39,171
Made for sale, tons	890,276	720,210
Value	$31,797,329	$28,134,175
Production by process		
Electrolytic, total production, tons	472,784	322,401
Consumed where made	64,442	34,881
Made for sale, tons	408,342	287,520
Value	$13,906,703	$11,263,248
Lime-soda, total production, tons [11]	488,807	436,980
Consumed where made, tons	6,873	4,290
Made for sale, tons	481,934	432,690
Value	$17,890,626	$16,870,927
Other hydroxides, value	$1,326,815	$900,984
Hypophosphites, value	$73,968	$29,190
Iodides, total value	$793,609	$745,324
Potassium, pounds	612,696	433,489
Value	$599,027	$572,161
Sodium, pounds	42,062	38,024
Value	$81,413	$82,038
Thymol, pounds	8,402	6,615
Value	$27,919	$21,935
Other iodides, value	$85,250	$69,190
Iodine, resublimed		
Pounds	369,270	199,816
Value	$399,088	$238,357
Lactates, value	$236,884	$91,487
Linoleates, total value	$176,443	$127,971
Cobalt, pounds	[13]	408,201
Value	[13]	$95,155
Other linoleates, value	$176,443	$32,816
Mercury, ammoniated		
Pounds	57,230	60,269
Value	$100,789	$82,275
Mercury, redistilled		
Pounds	162,196	74,817
Value	$221,801	$85,956
Modified sodas, tons	26,497	29,103
Value	$1,050,953	$1,140,022
Nitrates, except sodium [1],		
Total value	$4,334,591	$3,321,566
Bismuth, sub. pounds	262,867	269,193
Value	$309,678	$360,303
Silver (lunar caustic)		
Ounces	7,249,421	5,194,507
Value	$2,284,922	$1,907,693
Ammonium, pounds	45,560,194	25,297,894
Value	$1,130,764	$673,704
Zinc, pounds	7,241	12,502
Value	$2,501	$2,594
Other nitrates, except sodium, Value	$606,726	$377,272
Oxalates, total value	$254,439	$148,984
Iron, pounds	[1]	7,869
Value	[1]	$3,873
Other oxalates, value	$254,439	$145,111
Oxides, total value	$14,750,185	$8,770,428
Aluminum, tons	[13]	22,035
Value	[13]	$3,852,141
Mercury, pounds	162,224	119,813
Value	$218,075	$141,922

(Continued next page)

ing new work has been the continued experimentation on the highly concentrated metaphosphate developed by T.V.A. This compound (65 per cent available P_2O_5) does not appear to be suitable for mixed fertilizer and does not make its plant food quickly available in alkaline soils, or when used in low concentrations. But it does seem to have some possibilities for successful use as a direct fertilizer on certain crops in acid soils. No commercial work has been developed, nor has this been suggested as yet by T.V.A., in view of the uncertainty remaining as to agronomic significance.

During 1938 the fertilizer industry made a new study of the capacity for processing fertilizer phosphates.* It was demonstrated that the present plants in the United States could readily produce 8,850,000 tons of normal superphosphate, and over 210,000 tons of concentrated superphosphate per year. This is equivalent to 10,830,000 tons of standard 16 per cent super, in striking contrast with 5,200,000 tons of maximum consumption any year. On the basis of this and an equally great over-capacity for mixed fertilizer, the industry continues to argue that there is no excuse for any State or Federal plant development.

*See also in this issue Waggaman's study of phosphate rock reserves, and the news report of the recommendations of the Joint Congressional Committee headed by ex-Senator Pope which has been studying the adequacy of phosphate resources.

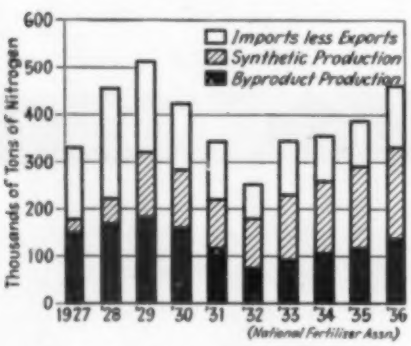
The industry is now giving new attention to the need for magnesium, boron, iron, copper, manganese and the other so-called minor constituents in phosphate fertilizers. This will, it is hoped, benefit phosphates by making their usefulness more certain and prompt.

Nitrogen

Most of the important trends in production and use of nitrogen by the fertilizer and by other chemical industries of the world continued during the past year with little interruption. In the United States the consumption of nitrogen fell off a bit, corresponding to the decline in farm purchasing of fertilizers; but world consumption continued to grow.

Chemical process industry continues to increase its share of the nitrogen business of the world. During the fertilizer year ending in 1938, synthetic producers supplied just 75 per cent of the total world production; byproduct producers supplied 17 per cent; Chilean nitrate, a poor third, supplied only 8 per cent of the inorganic nitrogen requirements. The accompanying tables show clearly in a quantitative fashion this and other im-

United States production and net imports of chemical nitrogen



*World Nitrogen Fixation Capacity 1931 and 1937 **

(Metric tons; compiled by Chisso Kyogi Kai, Tokyo, Japan)

Country	1931 Plants	1931 Capacity	1937 Plants	1937 Capacity
Germany	12	1,037,000	13	1,365,850
Japan	20	245,290	21	490,132
United States	8	203,650	10	292,510
France	22	207,550	27	244,050
England	2	185,500	2	232,870
Belgium	5	38,500	10	217,980
Soviet Union	1	7,300	4	157,500
Italy	14	90,250	18	146,860
Netherlands	2	34,000	3	136,650
Norway	3	108,000	4	121,000
Canada	2	73,200	3	102,000
Poland	6	99,000	5	88,930
Manchuria	...	....	1	40,000
Czechoslovakia	3	17,500	4	37,640
Yugoslavia	3	19,000	3	23,900
Sweden	3	8,000	3	14,036
Switzerland	3	12,600	3	13,200
Spain	3	7,700	3	8,000
Rumania	1	7,400	2	8,000
China	...	....	2	7,175
So. Africa	...	....	1	5,740
Hungary	...	....	1	5,740
Brazil	...	....	1	3,500
Bulgaria	...	....	1	60
Totals	113	2,401,440	145	3,763,323

* All new construction in this period was said to have been synthetic ammonia plants; no attempt has been made to check accuracy of these capacities.

United States Synthetic Nitrogen Balance, Fertilizer Year 1937–38

(Based on estimates prepared by Synthetic Nitrogen Products Corp.)

Supplies	Equivalent Short Tons of Nitrogen
Estimated output of	
Plant at Hopewell	90,000
Plant at Belle	85,200
Shell plant	15,000
Several small plants	6,000
Total	196,200
Disposition	
Consumed by U. S. agriculture in N-containing solutions, ammonia and ammonium phosphate	38,600
Consumed by U. S. agriculture as nitrate of soda (135,000 tons)	22,000
Consumed by Puerto Rican and Hawaiian agriculture as nitrate of soda (3,000 tons)	500
Consumed as sulphate of ammonia, mostly in U. S. agriculture (65,000 tons)	13,400
Consumed as nitrate of soda by U. S. industries (80,000 tons)	13,000
Consumed as ammonia and miscl. by U. S. industries	82,600
Exported as nitrate of soda (153,000 tons) and as urea (500 tons)	25,100
Exported as anhydrous ammonia, etc.	1,000
Total	196,200

*World Production of Inorganic Nitrogen **

(Thousands of metric tons of contained N)

Year	Chilean Nitrate	Synthetic	By-Product	Total
1910	382	8	204	594
1911	391	17	220	628
1912	401	30	245	676
1913	430	54	263	747
1914	382	70	243	695
1915	272	205	278	755
1916	451	262	310	1,023
1917	465	339	331	1,135
1918	444	416	332	1,192
1919	260	256	280	796
1920	391	421	352	1,164
1921	204	142	305	651
1922	166	312	234	712
1923	295	496	156	947
1923/24	344	404	315	1,063
1924/25	373	461	326	1,160
1925/26	406	590	344	1,340
1926/27	204	694	371	1,269
1927/28	395	912	422	1,729
1928/29	508	1,196	427	2,131
1929/30	465	1,264	476	2,205
1930/31	247	1,054	390	1,691
1931/32	169	1,084	332	1,585
1932/33	71	1,309	297	1,677
1933/34	84	1,351	351	1,786
1934/35	178	1,525	366	2,069
1935/36	192	1,776	410	2,378
1936/37	205	1,941	447	2,593
1937/38	224	2,135	491	2,850

* Source; Boletin Minero, No. 460, August 1938, Sociedad Nacional de Mineria, Santiago, Chile.

World Production and Consumption of Nitrogen

British Sulphate of Ammonia Federation estimates for the indicated fertilizer years, all expressed in thousands of metric tons of contained nitrogen.

Production:—	1928/29	1929/30	1930/31	1931/32	1932/33	1933/34	1934/35	1935/36	1936/37	1937/38
Sulphate of Ammonia:										
Byproduct	376	425	360	302	258	307	321	376	429*	411
Synthetic	485	442	349	522	560	535	533	630	688	765*
	861	867	709	824	818	842	854	1,006	1,117	1,176*
Cyanamide	192	264	201	134	168	195	232	269	291	305*
Nitrate of lime	136	131	110	79	118	107	153	156	179	195*
Other forms of Nitrogen**:										
Synthetic	383	427	393	348	462	516	607	724	851	931*
Byproduct	51	51	31	30	40	48	45	46	53	49
Chile nitrate	490*	464	250	170	71	84	179	192	206	224
Total production	2,113	2,204	1,694	1,585	1,677	1,792	2,070	2,393	2,697	2,880*
Percentage increase or decrease	+22.6%	+4.3%	−23.1%	−6.4%	+5.8%	+6.9%	+15.5%	+15.6%	+12.7%	+6.8%
Consumption:—										
Manufactured Nitrogen	1,453	1,587	1,377	1,417	1,620	1,714	1,877	2,223	2,492	2,620*
Chile nitrate	419*	364	244	138	127	164	195	218	238	252
Total consumption	1,872	1,951	1,621	1,555	1,747	1,878	2,072	2,441	2,730	2,872*
Percentage increase or decrease	+14.0%	+4.2%	−16.9%	−4.1%	+12.3%	+7.5%	+10.3%	+17.8%	+11.9%	+5.2%
Agricultural consumption about	1,670	1,750	1,455	1,412	1,586	1,673	1,812	2,106	2,369	2,492*
Percentage increase or decrease	+14.4%	+4.8%	−16.9%	−3.0%	+12.3%	+5.5%	+8.3%	+16.2%	+12.5%	+5.2%

* Record.

** Including nitrogen products used for industrial purposes (except Chile nitrate) and ammonia in mixed fertilizers.

Note.—Fertilizers are included in these tables under the final form as sold, so that, for example, cyanamide if converted into sulphate of ammonia is included under synthetic sulphate of ammonia, or, if into ammophos, is included under other synthetic nitrogen.

portant technologic and economic trends. In general the figures show that although 1938 fell a little below 1937, which was a record year in almost all nitrogen activities, still last year was a good business period for this industry, exceeding in most respects all previous years except 1937.

Potash

During 1938 the domestic producers of potash apparently supplied a little more than one-half of the entire domestic consumption. This was the first year that importers did not have at least a slight tonnage advantage.

The changes in the potash industry from 1937, which was a peak year of activity for the industry as a whole, to 1938, which was merely a good year, were significant. Although domestic production probably was a trifle above the preceding year, the shipments from domestic producers were slightly less. But the shipments by importers fell off much more.

Preliminary estimates indicate that the shipments of potash by producers and importers combined were about 8 per cent below the 1937 calendar year, a slightly smaller decline than that which occurred in the fertilizer manufacturing industry.

The K_2O content of fertilizers was a trifle higher in 1938, on the average, than during the preceding year, a continuance of the trend toward more concentrated mixed fertilizers, which has been going on for a number of years past. Apparently this trend favored potash more than either nitrogen or phosphate.

Prices of potash fertilizer materials during 1938 were slightly above 1937. Domestic production was principally by American Potash & Chemical Corp., Searles Lake, Trona, Calif.; United States Potash Co., and Potash Co. of America, both operating at Carlsbad, N. M. There was minor production also as cement and alcohol byproducts and elsewhere. Imports continued by Potash Export My, which Dutch firm represents in the United States the European cartel members. A major technical change was the availability of double capacity for production by the Potash Co. of America. The development of an additional mine in New Mexico is being continued by Union Potash Co., which is reported as owned by one of the major fertilizer concerns of the United States.

The first four companies named above constitute the American Potash Institute, which aggressively works on the development of new potash markets. The three present domestic producers constitute the membership of the Potash Export Association, newly organized under the Webb-Pomerene law for joint development of foreign markets. These foreign markets take typically up to 100,000 tons of potash materials, a sizeable percentage of the annual United States output.

Fertilizer potash deliveries were approximately 460,000 short tons K_2O for the calendar year 1938, compared with 500,000 tons for 1937. There was little change in the proportion of muriate and sulphate, the latter being considerably more expensive and being used only where muriate is not acceptable, namely in the citrus fruit and tobacco industries.

An important tendency away from cotton as the largest fertilizer consumer is shown by the figures from the American Potash Institute, giving the breakdown of fertilizer K_2O consumption by crops:

	Per Cent
Fruits and vegetables	21
Corn	18
Cotton	16
Potatoes	15
Wheat	12
Tobacco	10
All others	8

In 1937, the last year for which detailed figures are available on the potash industry, the operations of that industry in thousands of tons of K_2O were:

Domestic production	285
Imports	320
Total available	605
Agricultural sales	462
Chemical sales	18
Exports	63
Total accounted for	543
Apparent change in stocks on hand	+62

In fertilizer manufacture 50 and 60 per cent muriate make up the great majority of salts used, with sulphate under 10 per cent of the K_2O consumption. The principal potassium chemicals made domestically in 1937, as estimated by the American Potash Institute, were:

Chemical	Production, Tons	Imports, Tons
Bitartrate	1,927	11,910
Hydroxide	9,518	1,137
Chlorate and perchlorate	....	6,955
Carbonate	5,856	787
Acetate	2,245	....
Nitrate (refined)	....	1,164
Iodide	217	....
Citrate	88	....
Cyanide	....	44
All others	....	1,044
Totals	19,851	23,041

Salient Statistics of the United States Potash Industry, 1936–37

(Data from U. S. Bureau of Mines)

	1936	1937
Production (potassium salts), short tons	431,476	486,090
Equivalent K_2O	247,340	284,497
Sales (potassium salts):		
Short tons	396,690	466,933
Equivalent K_2O	222,810	266,938
Value at plant	$6,969,190	$9,019,534
Average per ton	$17.57	$19.32
Imports (crude and refined):		
Short tons	493,676	808,179
Equivalent K_2O	211,752	351,117
Value	$12,313,367	$19,688,306
Exports:		
Fertilizer material:		
Short tons	103,031	103,031
Value	$3,049,822	$3,278,895
Other:		
Short tons	2,333	2,094
Value	$487,347	$484,450

MOST RECENT CENSUS DATA

OXIDES, Cont'd	1937	1935
Tin, pounds	3,323,715	3,245,462
Value	$1,707,451	$1,685,692
Copper, cupric, pounds	1	1,169,875
Value	1	$219,486
Chromium, pounds	2,875,060	3,480,585
Value	$603,000	$756,708
Other oxides, value	[22] $12,221,659	$2,114,479
Peroxides, total value	$7,360,376	$3,850,162
Hydrogen, pounds (basis 100 volumes)	35,040,378	17,409,092
Value	$6,351,703	$3,154,593
Other peroxides, value	[23] $1,008,673	$704,569
Phosphates, total value	$13,676,275	$14,189,574
Calcium		
Monobasic, tons	41,116	35,860
Value	$5,139,402	$4,665,301
Dibasic, tons	2,048	2,714
Value	$108,335	$208,035
Tribasic, tons	9,626	2,015
Value	$624,800	$242,249
Sodium		
Tribasic, tons	100,550	87,100
Value	$3,922,434	$3,861,952
Dibasic, tons	17,425	35,444
Value	$752,004	$1,338,065
Monobasic and pyro		
Tons	12,989	4,517
Value	$1,749,275	$832,734
Meta, tons	7,748	5,147
Value	$946,002	$519,708
Other phosphates, value	[24] $433,933	$2,521,540
Resinates, total value	$145,316	$171,994
Cobalt, pounds	1	203,108
Value	1	$37,746
Manganese, pounds	1	599,299
Value	1	$60,092
Other resinates, value	$145,316	$74,156
Salicylates, total value	$565,690	$200,805
Magnesium, pounds	1	4,420
Value	1	$4,866
Other salicylates, value	$565,690	$195,939
Sodium aluminate, tons	7,238	6,770
Value	$437,625	$417,728
Sodium antimonate		
Pounds	4,347,866	4,100,543
Value	$554,047	$441,191
Sodium benzoate, pounds	1	1,354,893
Value	1	$391,332
Sodium borate (borax)		
Tons	126,166	106,131
Value	$3,416,184	$3,693,129
Sodium hypochlorite		
Tons (basis 15%)	75,073	50,807
Value	$6,274,888	$4,304,921

Sodium silicate		
Total value	$8,354,849	$7,673,591
Liquid, tons (basis 40°)	600,979	577,587
Value	$6,786,715	$6,607,204
Solid, tons	40,473	30,536
Value	$1,568,134	$1,066,387
Sodium silicofluoride		
Tons	5,601	2,628
Value	$582,723	$202,677
Stearates, total value	$1,773,468	$1,108,726
Aluminum, tons	2,258	1,896
Value	$856,771	$633,274
Calcium, pounds	980,101	491,673
Value	$191,839	$90,582
Zinc, pounds	2,073,110	1,718,979
Value	$421,463	$322,500
Other stearates, value	$303,395	$62,370
Sulphates, total value	$28,942,928	$21,497,368
Aluminum (conc. alum)		
Tons	394,438	348,030
Value	$8,782,089	$7,748,490
Aluminum-ammonium (ammonia alum), tons	14,397	5,188
Value	$505,954	$259,292
Barium (blanc fixe)		
Pounds	10,396,178	7,809,136
Value	$278,186	$235,832
Copper (blue vitriol)		
Pounds	71,917,889	54,759,439
Value	$4,073,654	$2,002,099
Iron (copperas)		
Tons	45,150	31,852
Value	$466,832	$311,516
Magnesium (epsom salt)		
Tons	41,369	38,489
Value	$1,216,748	$1,116,533
Manganese, pounds (100%)	14,127,276	6,211,704
Value	$333,033	$190,620
Potash and chrome alums		
Tons	3,227	2,666
Value	$203,960	$156,684
Sodium, total value	$5,103,926	$4,262,546
Anhydrous (refined) [25]		
Tons	21,797	23,609
Value	$312,285	$457,890
Glauber's salt, tons	31,934	39,961
Value	$490,660	$542,251
Hyposulphite (thiosulphate)		
Tons	39,486	24,477
Value	$1,411,764	$1,054,264
Niter cake		
Total production, tons	36,086	28,252
Consumed where made	13,103	9,438
Made for sale, tons	22,983	18,814
Value	$521,601	$343,890

(Continued next page)

CELLULOSE AND RESIN PLASTICS

New products and new applications for established plastics "keeps the pot boiling"

OUTSTANDING TRENDS in the plastics industry are toward: (1) the production of all varieties of both cellulose and synthetic resin plastics by a few large manufacturers; (2) the production of these materials by chemical manufacturers; and (3) the molding of plastics by the rubber companies. Among the most interesting features of the year is the substitution of vinyl resins for much of the cellulose acetate in interlayer material in safety glass. The use of plastics in airplanes is attracting considerable interest at this time because of several important developments.

Cellulose plastics followed the general economic trend, falling off in the closing months of 1937, remaining quiet until October, 1938, when demand increased rapidly. According to the Bureau of the Census the production last year of cellulose acetate sheets, rods and tubes amounted to 6,830,506 lb., which compares with 13,235,062 lb. in the previous year. The molding composition was 7,394,291 lb. (this is about 10 to 12 per cent less than in 1937) making a total of 14,224,797 lb. of acetate plastics produced last year. The price of plain colors was cut to 52½ cents a pound in December, black remained at 30 cents. No further decreases are anticipated.

The acetate molding material is increasing in demand as a result of the improvements in injection moldings for which it is especially suitable. Practically every automobile manufacturer uses acetate for steering wheels, and gadgets of many kinds on the cars. And now Chrysler is using an instrument board which is steel covered with acetate by injection molding. This covering is tougher than the lacquer finish. The method opens an enormous field to thermoplastics. Latest types of machines claim more than 75 sq.in. of projected mold areas. One model of press is of the vertical downward acting mold clamp type. Two 9-ounce capacity injection units are mounted on each side giving the press a total of 36-ounce injection capacity per shot. Another new development is injection molding machine in which the charge is brought up to temperature by means of induction heating.

During the year acetate lost some of its market for interlayer material in safety glass to the vinyl resins. It is estimated that 80 per cent of all safety glass made in 1938 contained acetate. While the vinyl resins will secure a large share of the market during the current year, it is generally believed that the two materials will become stabilized before the end of the year with the acetate retaining about 40 to 50 per cent of the business, although on this point there is a great difference of opinion. While some little cellulose nitrate was used in safety glass last year it has now ceased to be used for this purpose.

The Hercules Powder Co.'s acetate fiber plant at Parlin, N. J., is now operating and a second unit is under construction which will give this plant a capacity of about 5,000,000 lb. annually. Bakelite is offering a plastic made from this material. In the Fall the new acetate plant of the U. S. Industrial Chemicals Co. began operations. Both of these plants are using new methods.

The production of cellulose nitrate in the form of sheets, rods and tubes amounted to 21,158,768 lb. in 1937. This compares with 17,722,000 lb. last year. Prices remained steady.

For several years the Hercules Powder Co. has produced cellulose acetobutyrate. It is selling at 48 cents per pound. In December of last year, Tennessee Eastman Corp. announced its new acetobutyrate molding composition known as Tenite II. Though higher in price (60 cents per pound) its lower specific gravity makes it competitive with acetate materials. Its particular advantage is in its lower moisture absorption (approximately the same as nitrate) with decreased tendency to shrinkage and warpage, and a harder molded surface with better appearance and greater resistance to weathering. This new product is being received with favor. For a short time it will be available in limited quantities only.

Ethyl cellulose is being made by the Hercules and Dow companies, while it is being imported by Advanced Solvents and Chemical Corp. The principal applications are for varnishes, lacquers, resins, printing inks, electrical insulation, adhesives and leather finishing.

Polystyrene is produced by the Dow Chemical Co. and marketed by this company and the Bakelite Co. It is of par-

Synthetic resins: United States production and sales, 1921–37

Year	Production	Sales: Quantity	Sales: Value	Sales: Unit value
	Pounds	*Pounds*		
Coal-tar resins:[1]				
1921	1,643,796	1,674,456	$1,352,166	$0.81
1922	5,944,133	6,415,931	4,315,196	.67
1923–26	([2])	....	....	....
1927	13,452,230	13,084,313	6,094,656	.47
1928	20,411,465	20,778,856	7,211,958	.35
1929	33,036,490	30,660,513	10,393,397	.32
1930	30,867,752	24,014,093	7,323,656	.30
1931	34,179,000	29,343,000	7,862,000	.27
1932	29,039,000	23,891,000	5,001,000	.21
1933	41,628,485	31,657,653	7,238,560	.23
1934	56,059,489	43,350,876	10,126,849	.23
1935	90,913,162	65,923,334	12,777,195	.19
1936	117,301,780	86,213,735	17,056,099	.20
1937	141,098,844	108,284,175	20,165,064	.19
Non-coal tar resins:				
1932	1,898,000	1,787,000	796,000	.45
1933	3,571,717	3,256,411	1,745,102	.54
1934	([2])	3,500,829	1,491,145	.43
1935	([2])	([2])	([2])	....
1936	15,611,041	14,766,640	3,591,467	.24
1937	21,005,869	18,891,277	5,680,600	.30

[1] Does not include resins from adipic acid, coumarone and indene, hydrocarbon, polystyrene, succinic acid and sulfonamides. With the exception of coumarone and indene resins in recent years production of the resins not included was small.
[2] Not publishable. Figures would reveal operations of individual producers.
Source: Compiled from annual reports of the Tariff Commission on dyes and other synthetic organic chemicals in the United States.

Alkyd resins from phthalic and maleic anhydride: United States production and sales, 1933–37

Year	Number of makers	Production	Sales: Quantity	Sales: Value	Sales: Unit value
		Pounds	*Pounds*		
1933	6	9,930,705	3,654,854	$673,890	$0.18
1934	10	15,219,247	7,084,602	1,022,436	.14
1935	15	34,312,713	15,836,942	3,482,078	.22
1936[1]	31	46,952,452	24,252,535	5,312,121	.22
1937[1]	39	61,254,019	34,738,295	6,864,194	.20

[1] Includes resins from maleic anhydride.
Source: Dyes and Other Synthetic Organic Chemicals in the United States, U. S. Tariff Commission.

Urea resins: United States production and sales, 1933–37

Year	Production	Sales: Quantity	Sales: Value	Sales: Unit value
	Pounds	*Pounds*		
1933	3,234,356	2,977,791	$1,422,671	$0.48
1934	3,470,916	3,115,608	1,290,802	.41
1935	4,202,536	4,005,083	1,828,565	.46
1936–37	([1])	([1])	([1])	....

[1] Not publishable; figures would reveal operations of individual firms.
Source: Dyes and Other Synthetic Organic Chemicals in the United States, U. S. Tariff Commission.

ticular interest because of its electrical characteristics. A demand developed for this resin during the past year, however, the total volume is as yet comparatively small. The natural material sells at 62 cents per pound while Bakelite polystyrene, in a variety of colors, demands a price of 72 cents per pound.

Vinyl resins are being produced by Monsanto (through Shawinigan Products, Inc.), Carbide and Carbon Chemicals Corp., General Electric Co., B. F. Goodrich Co. and E. I. du Pont de Nemours & Co. The largest single application at this time is for safety glass sheets. As previously stated it is expected by the safety glass industry that 40 to 50 per cent of the 1939 production of interlayer material will contain vinyl resins.

The phenolic resins were lower in 1938. The molding resins (includes filler) produced amounted to 43,000,000 lb. An additional 20,000,000 lb. of phenolic resins were used for impregnating and all other applications, with the exception of adhesives for laminating. Prices for the molding materials remained unchanged, but prices for specialties such as adhesives were lowered about 10 per cent.

The cast phenolic resins branch of the industry suffered a slight loss in production. The 1938 output of 5,100,000 lb. compared with 5,459,654 lb. produced the previous year and the all-time high of 6,111,632 lb. in 1936. There have been no recent price changes. Radio cabinets and similar structural applications, and decorative buttons are the most important outlets. The use of the resin as an adhesive for laminated board continues to show promise. During the year the Catalin Corp. of America developed a split mold for use in casting the phenolic resins, which is expected to open a new field for the casting material.

Urea-formaldehyde resin production in each of the last two years was about 9,000,000 lb. (including filler). The last half of the year 1938 was much better than the corresponding period in the previous year, and the final quarter was the best in the history of the urea resin industry.

The basic price for granular molding composition in lots of 30,000 lb. or more remained constant at 27½ cents per pound, and the finely powdered molding composition in large quantities sold at 24½ cents per pound. However, there has been some softening noticeable among the compositions for impregnating fabrics, adhesives and other applications.

Rohm & Haas and duPont remain the only producers of the acrylate resins. The former company commenced production of these resins as early as 1931 and the latter organization produced methyl methacrylate resins in 1937. The liquid monomer being produced at the Belle, W. Va., plant of the company and shipped to the Arlington, N. J., plant for polymerization to the solid form. While the output of the acrylate resins was very small as late as 1936 it is said that very appreciable quantities have been made since that time and that their properties indicate large commercial production in the near future. The current price of the molding powder is 85 cents per pound in any quantity.

In September of last year it was announced that manufacturing licenses on a royalty basis would be granted by the Dairymen's League Cooperative Association on the milk plastic patent assigned to the League by William S. Murray. The new process uses skim milk but is reported to reduce costs over the direct casein products. The usual curing or hardening operation is avoided.

Cast phenolic resins: United States production and sales, 1934–37

Year	Production	Sales		
	Pounds	Quantity *Pounds*	Value	Unit value
1934	4,968,445	4,793,658	$2,099,035	$0.44
1935	5,566,621	5,454,490	2,205,879	.40
1936	6,111,632	6,013,855	2,476,619	.41
1937	5,459,654	5,335,746	2,180,620	.41

Source: Dyes and Other Synthetic Organic Chemicals in the United States, U. S. Tariff Commission.

Tar-acid resins: United States production and sales, 1927–37

Year	Production (net resin content)	Sales		
	Pounds	Quantity (net resin content) *Pounds*	Value	Unit value
1927 [1]	13,452,230	13,084,313	$6,094,656	$0.47
1928 [1]	20,411,465	20,778,856	7,211,958	.35
1929 [2]	26,235,792	25,129,701	9,869,274	.39
1930 [2]	18,338,380	17,428,687	6,576,023	.38
1931 [2]	22,647,000	21,496,000	6,646,000	.31
1932 [2]	17,163,000	15,042,000	3,946,000	.26
1933 [2]	31,697,780	28,002,799	6,564,670	.23
1934 [2]	40,663,565	36,086,008	9,037,861	.25
1935 [2]	52,731,728	46,733,378	8,730,438	.19
1936 [2]	70,349,328	61,961,200	11,743,978	.19
1937 [2]	79,844,825	73,545,880	13,300,870	.19

[1] All coal-tar resins.
[2] Resins from tar acids only.
Source: Compiled from annual reports of the Tariff Commission on dyes and other synthetic organic chemicals in the United States.

MOST RECENT CENSUS DATA

SULPHATES, Cont'd	1937	1935
Salt cake (crude)		
Total production, tons	269,177	192,384
Consumed where made	27,830	22,542
Made for sale, tons [26]	241,347	169,842
Value	$2,367,616	$1,864,251
Sodium-aluminum (soda alum), tons	[1]	18,217
Value	[1]	$1,040,580
Zinc, pounds	37,888,157	37,465,565
Value	$1,132,032	$721,025
Ammonium, tons	102,248	96,229
Value	$2,417,634	$2,073,258
Other sulphates, value	[27] $4,428,880	$1,378,893
Sulphides, total value	$2,408,544	$2,112,475
Sodium, tons (basis 60%)	31,419	24,884
Value	$1,594,360	$1,390,001
Ammonium, pounds (basis 100%)	[1]	842,248
Value	[1]	$85,730
Other sulphides, value	$814,184	$636,744
Sulphites, total value	$3,923,599	$3,752,458
Sodium, normal [28]		
Tons	12,491	6,840
Value	$781,877	$473,991
Sodium, formaldehyde, and zinc-hydro, pounds	16,032,500	15,076,836
Value	$2,503,683	$2,650,638
Other sulphites, value	$638,039	$627,829
Sulphur, refined, tons	[1]	47,504
Value	[1]	$1,649,758
Tartrates, total value	$1,302,411	$867,883
Potassium, bi- (cream of tartar)		
Pounds	5,080,455	3,855,022
Value	$418,765	$225,912
Other tartrates, value	[29] $418,765	$225,912
Vanillin, pounds	348,461	236,896
Value	$1,159,614	$684,723
Vitreous enamels ("frit")		
Pounds	76,527,104	73,397,433
Value	$5,201,732	$4,399,947
Other inorganic chemicals		
Value [30]	$123,122,481	$59,710,396
Other organic chemicals		
Value	[31] $77,919,395	$45,860,328

[1] Withheld to avoid disclosing approximations of data reported by individual establishments.

[2] Includes, in order of value, data for cellulose acetate, isopropyl acetate, aluminum acetate, potassium acetate, cobalt acetate, etc.

[3] Synthetic, natural dilute, and glacial.

[4] Data for production by establishments classified in Lead Smelting and Refining and Copper Smelting industries included.

[5] In addition 3,427,758 gallons of refined natural methanol, valued at $1,030,534 was produced for sale in the Wood distillations and Charcoal manufacturing industry.

[6] The production of ethyl alcohol, as reported to the Bureau of Internal Revenue, Treasury Department was 215,438,282 proof gallons in 1937, 193,218,597 proof gallon in 1935.

[7] Includes production from ammonia liquor. Amount of such production for 1937, 2,662,290 pounds, valued at $246,297; for 1935, 2,990,685 pounds, valued at $388,699.

[8] Include data for ammonia produced in Manufactured Gas industry.

[9] Electrolytic production was for interplant transfer and not for sale.

[10] Includes, in order of value, potassium carbonate, barium carbonate, ammonium bicarbonate, ammonium carbonate, sodium carbonate, monohydrate, etc.

[11] Sometimes called chloride of lime, calcium oxychloride, etc.

[12] Calcium chloride made by establishments engaged primarily in production of salt, reported by 4 establishments in 1937, amounted to 7,303 tons, valued at $66,591. In 1935, 8 establishments reported production of 8,044 tons, valued at $50,442.

[13] Data incomplete.

[14] Includes, in order of value, data for potassium chloride, stannic chloride, zinc chloride, sulphur chloride, barium chloride, etc.

[15] Includes, in order of value, data for lead chromate, ammonium chromate, etc.

[16] Does not include data for color lakes, nor for certain other coal tar chemicals, figures for which will be found in other tables for the Chemical group.

[17] Not including byproduct crudes made in coke plants and gas works.

[18] Includes, in order of value, data for sodium cyanide, sodium ferrocyanide, silver cyanide, zinc cyanide, potassium ferrocyanide.

[19] Reported as "refined" in 1935.

[20] Not including sodium hydroxide made and consumed in establishments classified in Wood-Pulp and Textile industries.

[21] Includes output of 2 establishments that produced caustic from natural soda ash.

[22] Includes, in order of value, data for aluminum oxide, titanium dioxide, antimony oxide, zinc oxide, iron oxide, arsenic trioxide, magnesium oxide, etc.

(*Continued next page*)

PRICE DECLINES IN SOLVENTS

Consumption of solvents was relatively high last year but many factors combined to unsettle values

TAKING the industry as a whole, a loss of 10 to 15 per cent in volume was recorded for solvents last year. It will be recalled that shipments of some solvents in the early part of 1939 were unusually high because stocks in the latter part of 1936 were depleted and deliveries originally scheduled for late 1936 shipment were not made until after the turn of the year. Giving consideration to this fact, the tonnage for solvents fell but little below that for the preceding year and made a commendable showing when compared with the drop in general business.

While some of the solvents held a fairly steady price course and higher prices went into effect on denaturing grade methanol, the general price trend was downward with some all-time lows established.

The Bureau of Internal Revenue issues official figures on operations at industrial alcohol plants but they apply to fiscal years ending June 30. However, monthly figures, subject to later revision, are available and they show that production of ethyl alcohol last year exceeded 192,000,000 proof gal. as against more than 215,000,000 proof gal. in 1937. This decline of more than 10 per cent in output was higher than that reported for production of denatured alcohol which fell only little more than 6 per cent, the figures being approximately 93,000,000, wine gal. for 1938 and 99,000,000 wine gal. for 1937. The drop in denatured alcohol output was entirely in the completely denatured as a small increase was reported for the specially denatured with more than 74,000,000 wine gal. produced while in 1937 the output fell short of that figure. A drop of more than 6,000,000 wine gal. in completely denatured volume, however, brought the total for both grades about 750,000 wine gal. below the 1937 figure.

Generally poor business conditions in the first part of last year affected demand for all types of solvents. Denatured alcohol was especially affected because the mild weather over a large area of the country materially cut down buying for anti-freeze use. Then, too, for the first time in several years, there was an unrestricted supply of permanent anti-freeze and methanol mixtures maintained their position in spite of the general decrease.

The early-year position of alcohol was involved by the prospect for abnormally large grain crops throughout the world which lessened demand for molasses as cattle food. Molasses had been firm through the first part of 1937 and the probability of a European war induced most producers of alcohol to contract for large amounts of molasses at relatively high prices. Last spring molasses inventories became burdensome and prices broke with a corresponding effect on values for alcohol which was aggravated by the fact that one of the smaller producers was able to take on molasses stocks at prices below the inventory costs of most other producers and passed this saving on to the consuming trade.

As the molasses situation began to improve one of the major alcohol producers in an attempt to obtain a larger gallonage was reported to have entered into a two-year contract with one of the large acetic anhydride producers for large quantities of ethyl alcohol on a cost plus basis. A competing acetic anhydride producer had been making anhydride from his own alcohol and this contract was cited as responsible for a shifting in volume which was reflected in a further general price decline.

Competitive selling also was prominent in the anti-freeze campaign. Opening prices were on the same basis as in the preceding year but in a short time a report was current to the effect that one producer had made a special price to a large private brand anti-freeze account. The producer who formerly supplied this account was then credited with signing up another of the large private brand accounts at a still lower price. Following which the producer who was previously reported as having an advantage of low-priced molasses was said to have put out quotations which represented a drop of about 5c a gal. from the original price level. At the close of the last quarter, all producers marked prices up one cent a gal. and the majority of buyers at once covered requirements for the first quarter of 1939 at the old prices and because of this it is expected that the current quarter will bring little of importance either in the way of price changes or of trading.

Production of crude and synthetic methanol followed the general downward trend, the former dropping about 27.5 per cent and the latter more than 18 per cent below the 1937 totals with a loss of 19.6 per cent in the combined totals. Producers of the synthetic product maintained their output at a high rate throughout the first quarter of the year and the first-quarter output of the wood distillation branch was higher than that for any other quarter of the year.

The manufacture of charcoal and wood chemicals in 1938 was carried on by the hardwood distillation industry at approximately 75 per cent of the 1937 rate. The following table shows the figures as reported to the Bureau of Census for total wood carbonized and crude methanol produced. The acetic acid equivalent is calculated from the wood carbonized.

	1937	1938
Wood carbonized (1000 cords)	574	413
Crude methanol produced (million gallons)	5.75	4.17
Acetic acid equivalent (million pounds)	60	43

During recent years the trend toward synthetic production of methanol has advanced considerably. Census figures for 1936 show that 84 per cent of the meth-

Operations at Ethyl Alcohol Plants

		1936-7	1937-8
Number of plants operated [1]		38	36
Number of bonded warehouses operated		73	68
Operations (Proof gallons [2])			
Production		223,181,228	201,033,858
Removed to bonded warehouses		222,828,218	200,343,151
Withdrawals, total[3]		215,220,823	196,878,568
Tax-paid		32,289,650	28,976,609
Tax-free, total		182,931,173	167,901,959
For denaturation [3]		179,324,373	164,263,210
For hospital and scientific use		1,764,740	1,849,899
For use of U. S. and subdivisions		1,041,828	950,760
For export		163,156	167,534
For medicinal, beverage and other authorized uses in Puerto Rico		637,076	670,556
Losses in warehouses		528,194	524,879
Losses in transit		39,871	41,048
Stocks in bonded warehouses June 30 [4]		28,464,541	32,046,632
Materials used			
Molasses	gal.	202,631,056	162,557,843
Grain			
Corn	lb.	198,467,734	189,235,346
Malt	lb.	29,247,273	26,832,102
Rye	lb.	4,598,838	5,386,117
Other [5]	lb.	344,162	363,695
Ethyl sulphate	gal.	25,492,675	26,577,150
Sulphite liquor	gal.	12,060,125	....
Pineapple juice	gal.	3,598,222	2,007,339
Cider	gal.	34,820	....
Corn sirup	gal.	28,446	....
Fermented liquor	gal.	23,157	....
Manioca meal	lb.	634,552	156,296
Miscellaneous	lb.	58,845	16,350

[1] Includes 3 experimental plants in 1937 and 1 in 1938.
[2] A proof gallon contains 50 per cent alcohol by volume.
[3] Includes 194,606 proof gal. in 1937 and 666,271 proof gal. in 1938 transferred to denaturing plants by alcohol plants not having bonded warehouses.
[4] Stocks in transit between bonded warehouses and quantities in receiving tanks of alcohol plants awaiting transfer to bonded warehouses not computed.
[5] Includes 19,180 lb. of diamalt in 1937 and 17,114 lb. in 1938.

Production of Methanol

1938	Production Synthetic gal.	Crude[1] gal.
January	2,896,894	458,347
February	2,290,609	408,930
March	2,343,828	432,800
April	1,975,999	314,664
May	1,860,400	330,875
June	1,629,570	293,091
July	1,449,607	309,219
August	1,897,847	281,988
September	1,929,655	303,225
October	2,294,532	335,380
November	2,617,979	344,328
December	2,844,249	357,249
Total	26,031,169	4,170,096
1937		
January	1,835,815	525,070
February	1,849,302	500,685
March	2,071,747	546,662
April	2,138,895	531,727
May	2,353,497	522,961
June	2,263,507	485,943
July	2,564,783	465,205
August	2,735,963	462,584
September	3,018,333	404,112
October	3,532,091	423,792
November	3,562,372	423,315
December	3,887,741	461,539
Total	31,814,046	5,753,595

[1] The refined equivalent would be approximately 85 per cent of the crude production.

anol was produced synthetically; in 1938 this had risen to 88 per cent.

The shift from acetate of lime recovery over to direct acid recovery has proceeded more rapidly. In 1936 the total industry capacity was slightly over 60 per cent in plants which recovered acetate of lime. In 1938 this ratio had been practically reversed so that almost 60 per cent of the 2,580 cords capacity was equipped for direct recovery. Actual production figures for 1938, however, were still more startling. According to the best estimates two-thirds of the actual acetic acid equivalent production was by direct recovery or approximately 28 million pounds. This represents a significant increase over the preceding year's direct recovery of 20 million pounds. It can be seen that the acetate of lime recovery must have absorbed the shock of the recession, dropping in 1938 to approximately one-third of 1937 figures and being only one-third of the 1938 total production.

Methanol, like other solvents, found a more restricted market last year but in contrast to other solvents maintained a steady position and denaturing grade recovered the 5c per gal. reduction which went into effect in the preceding year. Consumption was adversely affected by the lowering in demand for resins consuming formaldehyde and the loss in textile business was reflected in the demand for dyes.

Butyl alcohol reached a record production total of 124,464,656 lb. in 1937 and the output of butyl acetate rose to 76,352,160 lb. Both production and consumption of these products fell off last year although definite figures are not available. The decline in automotive production reacted strongly on the demand for butyl alcohol and this was more noticeable because one of the three largest automobile manufacturers changed over entirely to resin finishes. In spite of the recession in consuming demand, prices for butyl alcohol held fairly steady for the greater part of the year. In the last quarter a producer who was rather short of stocks, pushed up production and under the enlarged offerings, lower prices became effective and the price situation was none too strong as the year ended.

Ethyl acetate practically paralleled the course taken by butyl acetate both in the way of a declining consuming market and in competitive selling which resulted in lower prices. The drop in prices for ethyl acetate in the last two years more or less directly was reflected in the market for acetic acid as the drop in acetate brought pressure for lower prices for the acid and as two of the largest acetic acid consumers became producers last year, the sales market contracted accordingly and the year closed with the market in an uneconomic position which was not helped by the possibility that the lowering in duty as effected by the trade agreement with Canada might encourage competition from that country.

The most important development, perhaps, in the market for acetone was found in large amount which entered into foreign trade. As the tendency of foreign countries is to become self sufficient, in fact some of them in 1937 reached a point where importations were unnecessary, it was not expected that foreign buying would be important in 1938. Yet outward shipments amounted to 10,428,435 lb. for the first 11 months of the year as compared with 9,653,659 lb. for the 12 months of 1937. In 1937, exports were valued at $626,113 or an average of slightly under 6½c a lb. whereas the 1938 valuation was $582,312 or an average of 5.6c per lb. The war scare in Europe together with heavy buying for shipment to the Far East account for the larger foreign trade and incidentally this buying helped to stabilize the domestic market by reducing the large inventory carried over from 1937 even though very low prices aided in the move to attract buyers from outside markets.

Reduced operations at textile plants were prominent in cutting down domestic buying of acetone last year but the improved stock position combined with the improvement in business in the latter part of the year gave an undercurrent of firmness with predictions that a continuance of the business trend would bring higher sales prices for acetone. Competition, reportedly emanating from a change in supplier to a textile company, entered the price-cutting stage and sales were reported on a basis of 4¼c a lb. in tank cars delivered.

MOST RECENT CENSUS DATA

CHEMICALS, Cont'd.

[23] Includes, in order of value, data for sodium peroxide, barium peroxide, lead peroxide, etc.

[24] Includes value of ammonium phosphate, etc.

[25] Includes data for anhydrous sodium sulphate made from brine.

[26] Includes data for natural salt cake made from brines.

[27] Includes, in order of value, data for nicotine sulphate, soda alum, nickel sulphate, satin white, chromium sulphate, etc.

[28] Anhydrous and crystal.

[29] Includes data for potassium-sodium tartrate, etc.

[30] Includes, in order of value, data for aluminum metal, sodium nitrate (refined), calcium molybdate, sodium metal, sulphur (refined), silicon carbide, yellow phosphorus, calcium hypochlorite (true), sodium perborate, sodium nitrite, sodium succinate, etc.

[31] Includes in order of value, data for tetraethyl lead, nitrocellulose (not plastic), ethylene glycol, formaldehyde, casein, trichlorethylene, etc.

CLAY PRODUCTS

	1937	1935
Aggregate value	$258,499,651	$158,461,037
Other than pottery		
Total value	$161,081,137	$90,177,576
Common brick, thousands	3,252,633	1,811,341
Value	$34,009,775	$18,238,060
Face brick, thousands	959,036	472,587
Value	$14,451,503	$7,011,056
Hollow building tile		
Glazed, tons	186,910	
Value	$2,210,055	842,264
Unglazed, tons	1,363,073	$4,963,484
Value	$7,732,279	
Enameled tile, sq. ft.	26,049,357	12,100,646
Value	$8,258,479	$3,551,485
Sewer pipe, tons	973,142	670,181
Value	$13,718,240	$8,617,133
Fire-clay products		
Brick, block or tile, except high-alumina, thousands	710,757	481,679
Value	$33,730,843	$19,495,591
High-alumina (over 40% Al_2O_3) brick, thousands	27,459	13,220
Value	$2,133,675	$1,071,029
Special shapes, tons	184,212	156,111
Value	$4,750,779	$3,264,729
Plastic firebrick, tons	44,011	[1]
Value	$1,281,753	[1]
Ladle brick, thousands	67,401	
Value	$1,565,134	
Refractory cement (clay)		
Tons	57,927	36,905
Value	$2,467,771	$1,734,855
Pottery, total value	$97,418,514	$68,283,461
Chemical stoneware	$876,636	$617,042
White ware	$25,711,410	$22,164,328
Hotel china	$10,017,811	$7,197,700
Porcelain electrical supplies, Value[2]	$24,836,731	$12,751,034

[1] No data. [2] Value of metal fittings included in 1937, $1,674,391; in 1935, $1,039,345.

CLEANING AND POLISHING PREPARATIONS

Aggregate value	$50,439,928	$41,762,354
Made as secondary products in other industries (included above), value[1]	$10,521,512	$7,232,210
Cleaning preparations		
Total value	32,962,848	23,930,079
Containing no soap		
Value	23,985,599	17,659,623
Containing soap		
Value[2]	8,977,249	5,525,925
Other cleaning preparations,		
Value	....	744,531
Polishing preparations		
Total value	24,841,164	15,817,740

[1] Not including value of cleaning preparations containing soap. [2] Value of production in cleaning and polishing preparations industry only.

COMPRESSED AND LIQUIFIED GASES

Aggregate value	$84,536,717	$67,142,152
Made as secondary products in other industries (included above) value	29,819,256	26,385,549
Ammonia, anhydrous[1]		
Pounds[2]	223,040,588	138,778,725
Value[2]	$8,867,638	$5,679,399
Chlorine		
Total production, tons[3]	446,261	315,139
Consumed where made		
Tons[3]	160,301	107,759
Made for sale, tons	285,960	207,380
Value	$10,416,672	$7,961,186
Hydrogen		
M cubic feet	1,103,177	743,860
Value	$1,848,529	$1,556,658

(Continued next page)

RAYON AND OTHER FIBERS

Although rayon production dropped from that of 1937, consumption was considerably larger in 1938

RAYON PRODUCTION in 1938 was only slightly greater than that of 1935, and 7.1 per cent below 1936. The decrease from record year, 1937, was 19.9 per cent. However, far from being a bad sign, this decrease in production is a healthy indication and further evidence of the economic controllability of rayon in comparison with the natural fibers. Furthermore, although production declined, consumption reached a higher level than in any previous year save one, being 2.6 per cent above 1937.

Still another healthy situation in the industry's 1938 picture was the reduction of finished yarn stocks at the plants to a figure more closely approaching the normal. Ordinarily, stocks are carried by the industry at a point between 20,000,000 and 30,000,000 lb. By the end of 1936, however, stocks had fallen to 4,000,000 lb., yet at the close of 1937, they had risen to nearly 60,000,000 lb. Now after a year of heavy consumption, stocks are at a reasonable point, having been reduced by over 20,000,000 lb. during 1938.

Production of filament yarns in 1938 was 257,916,000 lb. compared with 321,681,000 lb. in 1937 and 277,638,000 lb. in 1936, according to the *Rayon Organon* which recently released the industry's official statistics. From the figures for domestic shipments and foreign trade, the *Organon* estimates that domestic consumption reached 274,050,000 lb. in 1938, compared with 267,074,000 lb. in 1937 and 297,602,000 lb. in 1936. Including apparent consumption of staple fiber, the total synthetic fiber usage was 327,387,000 lb. in 1938, 307,932,000 lb. in 1937 and 322,623,000 lb. in 1936.

One fact which is not apparent from the comparative production statistics is the effect on output due to the reduction in average denier in 1938 as compared with 1937. According to the *Organon*, in 1937 the average denier was 142 and in 1938, 137. Since the production at a given operating rate is substantially in proportion to the denier, the operating rate in 1938 was considerably higher than indicated by the tonnage. Had the average denier in 1938 equalled that of 1937, production would have approximated 270,000,000 lb.

Of the filament yarn production, 70.5 per cent or 181,795,000 lb. was viscose plus cuprammonium, according to the *Organon*. Of this quantity, we estimate some 9–10 million lb. was cupra. Acetate production amounted to 76,121,000 lb. For comparison, in 1937 viscose plus cupra amounted to 239,316,000 lb. and acetate to 82,365,000 lb. Thus the practically unbroken trend toward a greater percentage of the total for acetate has continued. Where viscose plus cupra declined 24 per cent from 1937 to 1938, acetate lost but 8.3 per cent in the same period.

In recent years, rayon men have begun to eye the cotton market speculatively, and with considerable reason, for the trend of rayon encroachment on cotton markets has been almost a continuous increase. For example, rayon consumption stood at 4.5 per cent of cotton in 1930, 6.2 per cent in 1932, 7.4 per cent in 1934, 8.5 per cent in 1936 and 9.4 per cent in 1938.

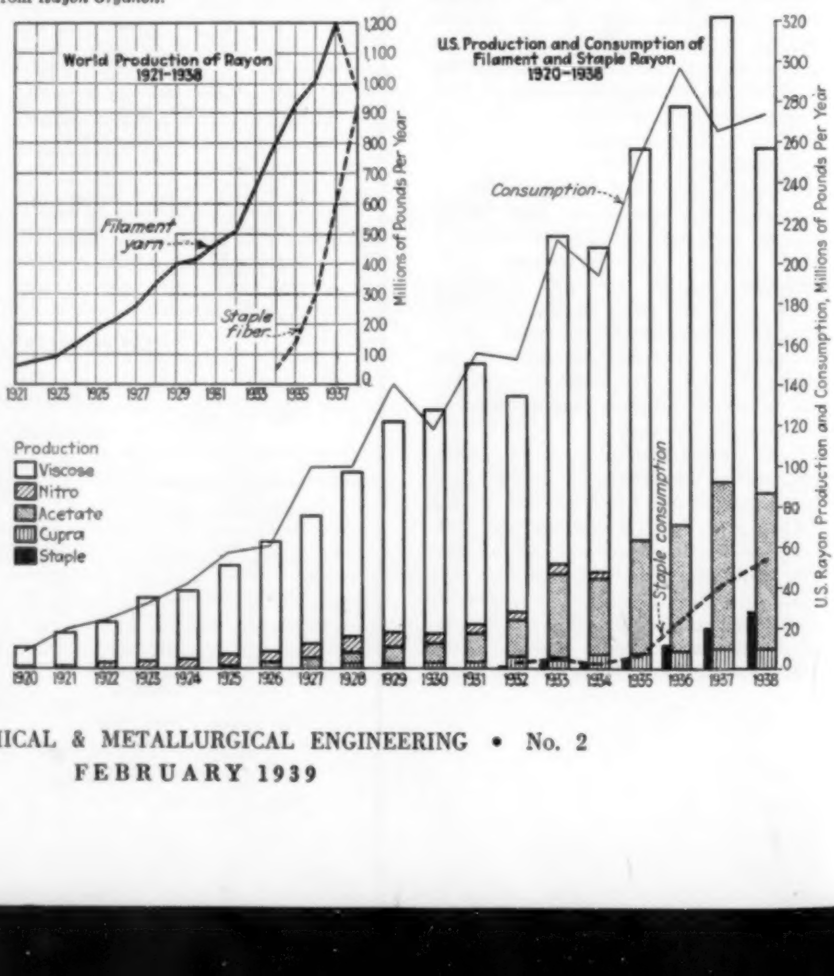
Throughout the world, staple fiber has been growing at a tremendous rate in recent years, particularly in Japan, Germany and Italy, where self-sufficiency programs have necessitated its greatly increased use. This situation is well portrayed in one of the accompanying tables which is taken from an excellent report on the development and use of rayon and other synthetic fibers, recently released by a joint committee of the Bureau of Agricultural Economics and the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

A belief in a glowing future for staple rayon has been slow to develop within the industry in the United States and there is still a feeling on the part of some producers that current interest is over-emphasized in this country. It was not until 1935 that staple production began to expand sharply, as is shown in the accompanying table and on the pro-

*Percentage of Total Rayon Production Which Was Staple Fiber**

Year	United States	Japan	Germany	Italy	Great Britain	France	Other	World total
1929	0.4	....	3.9	2.3	4.7	....	....	1.6
1930	0.2	....	6.9	1.0	1.7	....	....	1.4
1931	0.6	....	6.6	1.9	2.2	1.1	....	1.7
1932	0.8	0.9	9.0	13.1	1.7	3.1	0.6	3.7
1933	1.0	1.0	12.3	13.0	2.9	3.7	0.5	4.0
1934	1.0	3.0	15.7	20.1	2.6	7.1	0.8	6.3
1935	1.8	5.7	28.0	44.1	7.7	7.5	1.2	12.9
1936	4.2	14.3	48.9	56.1	18.3	9.7	2.5	22.6
1937	5.9	34.3	63.8	59.5	21.5	14.5	6.0	34.4
1938	10.7	....	....	....	....	....	....	48.6

* From Bureau of Agricultural Economics. Production figures used in computing these percentages from *Rayon Organon*.



Rayon Production and Imports, 1921–1938

	Thousands of Pounds		
	U. S.* Production	U. S.† Import Balance	World* Production
1921	18,000	3,276	65,000
1922	26,000	2,116	80,000
1923	35,000	3,029	97,000
1924	38,750	1,954	141,000
1925	52,200	5,293	185,000
1926	62,575	8,945	219,000
1927	75,050	14,633	267,000
1928	97,700	11,948	345,000
1929	121,399†	14,832	404,000
1930	127,333†	5,995	417,000
1931	150,879†	1,490	470,000
1932	134,670†	−456	509,000
1933	213,498†	−176	660,000
1934	208,321†	−2,432	799,589
1935	257,557†	−2,193	932,780
1936	277,626†	−1,558	1,021,000†
1937	321,681†	−525	1,205,000†
1938	257,916†	−1,175	975,000†

* From *Textile World* except as noted; does not include staple.

† From *Rayon Organon*. Does not include staple which is estimated at 350,000 lb. in 1930; 880,000 lb. in 1931; 1,100,000 lb. in 1932; 2,100,000 lb. in 1933; 2,200,000 lb. in 1934; 4,600,000 lb. in 1935; 12,300,000 lb. in 1936; and 20,244,000 in 1937. World staple estimated at 6,100,000 lb. in 1930; 52,700,000 lb. in 1934; 139,900,000 lb. in 1935; 298,000,000 lb. in 1936; 618,000,000 lb. in 1937 and 925,000,000 lb. in 1938. Import balance does not include staple; minus sign indicates net exports; staple imports 12,718,000 lb. in 1936, 20,610,000 lb. in 1937, 23,500,000 lb. (est.) in 1938.

Approximate Consumption of Wood Pulp and Linters in Making Rayon in the United States, 1929–1937[1]

Tons, 000 omitted

Year	Viscose and Cuprammonium		Acetate	Nitro-cellulose	All Processes	
	Linters	Wood pulp	Linters	Linters	Linters	Wood pulp
1929	18	44	3	4	25	44
1930	20	46	3	3	26	46
1931	24	53	5	3	32	53
1932	21	44	6	4	31	44
1933	35	62	14	4	53	62
1934	34	64	13	2	49	64
1935	32	89	18	..	51	88
1936	[2]	[2]	21	..	[2]	[2]
1937	14	139	28	..	42	139

[1] From Bureau of Agricultural Economics; quantities estimated and only approximately correct.
[2] Data not available.

duction and consumption charts. By far, the most important factor tending toward a large increase in viscose staple consumption is the advent of a "stabilizing" process for staple fiber products, similar to the anti-creasing process introduced from England several years ago for use with filament yarn and natural fiber fabrics. Where originally a phenol formaldehyde resin was formed in the fabric, for staple treatment a urea formaldehyde resin is generally used, while acrylic resins are also being considered for the purpose. Röhm & Haas Co. of Philadelphia, and the Du Pont company have been pushing this development actively and it appears that both men's and women's clothing using the process will appear on the market in considerable quantity during the coming summer.

Apparently the stablizing process does not effect as much improvement in acetate staple as in viscose, but at least one acetate producer has found it possible to produce an excellent product without resin reinforcement. Teca, the new crimped acetate staple introduced by Tennessee Eastman Corp., has decided wool-like mechanical qualities, producing a resilient spun yarn which has been found satisfactory for suitings and other fabrics and even in the manufacture of blankets.

Statistics are not available to show the present United States capacity for staple fiber, but it is known to be large. One manufacturer recently installed what was said to be a 25,000,000 lb. per year plant with another unit of similar size under construction. Another installed about 10,000,000 lb. capacity and these figures are in addition to a probable 25-40,000,000 lb. capacity previously existing. For filament yarn, the *Organon* recently reported a net operating capacity of 365,000,000 lb. as of November, 1938, with 400,000,000 lb. capacity contemplated for the Spring of 1940. Operating capacity, it should be noted, is taken as 90 per cent of theoretical capacity, to allow for denier change-over, the spinning of smaller deniers and various contingencies.

The year was one of active development, with particular emphasis on totally new fibers. Probably the most spectacular news was the announcement of the new Du Pont fiber, nylon, which bears a close chemical resemblance to natural silk, both materials being polyamides of protein-like structure. The material has a remarkably high degree of elasticity and is expected by its makers virtually to displace natural silk in the production of hosiery. Although the company has emphasized the derivation of nylon from coal, air and water, actually, the raw materials at present in use are said to be intermediates available in relatively small quantities. The company's present production of materials of the class of nylon is going largely into synthetic bristles, and kindred products, such as leaders for fishing lines. With the completion of the $7,000,000 plant at Seaford, Del., more and more of the production will be turned out in the form of yarn as the operating problems are solved through large-scale production.

Other new fibers are still in the experimental state or at least in an unreported condition. Celanese Corp. has announced that it is spending $10,000,000 on a plant at Pearisburg, Va., to produce a new fiber of a type not yet announced,

(*Please turn to page* 132)

MOST RECENT CENSUS DATA

GASES, Cont'd	1937	1935
Hydrocarbon gases		
Acetylene		
M cubic feet	1,511,445	1,143,199
Value	$19,166,420	$14,747,824
Liquefied petroleum gases, M gallons	116,054	374,719
Value	$3,903,733	$7,989,298
Other hydrocarbon gases		
Value	813,775	501,338
Nitrous oxide		
M gallons	97,768	95,861
Value	$1,114,113	$945,802
Oxygen M cu. ft. total	4,441,391	2,683,859
Liquefaction process	4,318,410	2,592,714
Electrolytic process	122,981	91,145
Value	$26,072,822	$18,125,676
Sulphur dioxide		
Pounds	28,717,125	24,628,183
Value	$1,477,146	$1,170,401
Carbon dioxide (excluding "dry ice")		
Pounds[4]	100,715,662	87,657,446
Value	$4,939,508	$4,541,329
Solid carbon dioxide ("dry ice")		
Pounds	313,217,310	165,123,912
Value	$4,618,937	$3,245,691
Other gases, value	1,297,424	677,549

[1] Made in the Chemicals N.E.C. industry for 1937 and in the Chemicals N.E.C. and the Manufactured Gas industries for 1935. Does not include production in the Coke industry. [2] Includes production from ammonia liquor. Amount of such production for 1937, 2,662,290 pounds, valued at $246,297; 1935, 2,990,685 pounds, valued at $388,699. [3] Not including chlorine made and consumed in Wood Pulp industry. [4] Includes carbon dioxide piped to plants making "dry ice." Quantities thus piped in 1937, and 1935 (estimated), 17,000,000 pounds, and 25,285,000 pounds, respectively.

DRUGS AND MEDICINES

Aggregate value	$335,809,674	$280,760,446
Alkaloids and derivatives, made for sale		
Pounds	2,063,918	1,062,520
Value	$7,116,593	$6,130,792
Biological products		
Value	17,679,434	13,412,335
Other products sold direct to or prescribed by physicians, value	$118,874,633	$113,657,441
Medicines in specially prepared packages made for sale to the general public, value	180,151,504	136,458,467

EXPLOSIVES

Total pounds	438,523,911	338,116,413
Total value[1]	$48,764,985	$34,655,156
Dynamite, pounds	256,647,677	191,190,664
Value	$26,949,809	$19,715,009
Permissible explosives[2]		
Pounds	71,289,248	47,990,826
Value	$7,466,338	$4,965,657
Nitroglycerine consumed in shooting wells on contract and made for sale, pounds	3,433,594	2,483,262
Amount received for shooting wells on contract[1] and value of production for sale	$1,636,919	$818,748
Blasting powder, pounds	32,192,875	35,153,125
Value	$2,009,925	$2,147,814
Pellet powder, pounds	33,423,657	31,467,150
Value	$2,137,152	$2,076,261
Fuse powder, pounds	2,438,775	1,477,975
Value	$438,109	$231,654
Gunpowder (black and smokeless) and other explosives not specified above, pounds	39,098,085	28,353,411
Value	$8,126,673	$4,680,013
Fireworks and allied products, aggregate value	8,093,111	6,451,602

[1] Amount received for shooting wells is treated as value of nitroglycerine used for this purpose. [2] Those approved by the Bureau of Mines, Department of the Interior, as suitable for use in mines where dust and gas explosions are likely to occur.

FERTILIZERS

Aggregate, tons	8,943,788	6,459,780
Value	$170,402,122	$120,640,436
Made as secondary products in other industries (included above) tons	163,309	238,991
Value	$4,492,607	$5,205,574
Complete fertilizers, tons	5,651,578	4,201,581
Value	$127,863,320	$93,091,644

(*Continued next page*)

COKE AND COAL PRODUCTS

The final quarter of the year lifted coke and byproducts back to 1936 levels

COKE AND COAL PRODUCTS manufactured during 1938 were at an unusually low level because of the depression conditions in the steel industry. But toward the latter part of the year renewed business activity pulled coke and byproducts back about to 1936 levels with prospects that early figures in the new year would be near the 1937 average.

The production of byproduct coke during 1938 was about 32 million tons, or a little over 60 per cent of the 1937 total. As is customary in years of slack business, the beehive division of the industry dropped off so that only about 860,000 tons of this type of coke was made, hardly more than a quarter the production of the preceding year. The stocks of byproduct coke at the end of the year were over 40 per cent above those at the end of 1937—over 3.5 million tons.

During March, 1938, one new plant of merchant byproduct ovens began operation. And later in the year additions of new batteries to other old plants were first fired. During the year several plants shut down either completely or in one or more batteries, but these fluctuations were normal for a period of slack activity. At the low point of the year (June) the operations represented a drop of 55 per cent from the high level of 1937, reached in March.

Recovery of byproducts during the year is estimated on the basis of the typical ratio of these products to the coal used, as follows:

Gas	490,000,000 cu. ft.
Tar	390,000,000 gal.
Ammonium sulphate	870,000,000 lb.
Ammonia liquor (NH_3 content)	44,000,000 lb.
Crude light oil	120,000,000 gal.
Naphthalene	40,000,000 lb.

The net change in number of ovens operating and operable at the end of 1938, as compared with the preceding year, was approximately 150 ovens. Throughout the year from 79 to 83 plants were operating. The accompanying tabular matter indicates outstanding operating results for 1937, the last year for which byproduct figures are available.

Coke-oven Tar in the United States, 1937

Data From the U. S. Bureau of Mines

Total produced	603,000,000 gal.
Used in open hearth, steel, or other affiliated plants	121,000,000 gal.
Used by producer as boiler fuel	2,000,000 gal.
Used otherwise	2,000,000 gal
Sold for refining into tar products	290,000,000 gal.
Sold for fuel	96,000,000 gal.
Apparent change in stocks	92,000,000 gal.
Total value of sales	$18,456,483
Average value	4.8 c. per gal.
Yield of tar per ton of coal coked	8.67 gal.

Domestic production of naphthalene has increased tremendously in recent years for two reasons: (1) alkyd resins have required more and more of the naphthalene derivative, phthalic anhydride; and (2) importation has been restricted. The 1936 shortage forced the price up to the point where recovery was more profitable. The following data are of interest because they show the growth of this industry over a 13-year period.

Byproducts Obtained from Coke-Oven Operations in the United States in 1937[1]

(Exclusive of screenings or breeze)

Product	Unit	Production	Sales: Quantity	Sales: Value: Total	Sales: Value: Aver.
Tar	Gal.	603,053,288	386,648,478	$18,456,483	$0.048
Ammonia:					
Sulphate	Lb.	1,289,740,739	1,332,308,748	14,477,234	.011
Ammonia liquor (NH_3 content)	Lb.	54,172,628	52,394,717	1,571,091	.030
		....	....	16,048,325	......
Sulphate equivalent of all forms	Lb.	1,506,431,251	1,541,887,616	....	......
Gas:					
Used under boilers, etc	M. cu. ft.	[2] 757,628,942	32,776,758	1,969,693	.060
Used in steel or affiliated plants	M. cu. ft.		251,571,649	25,419,223	.101
Distributed through city mains	M. cu. ft.		150,936,668	42,657,825	.283
Sold for industrial use	M. cu. ft.		27,757,884	2,914,956	.105
		....	463,042,959	72,961,697	.158
Light oil and derivatives:					
Crude light oil	Gal.	[3] 187,054,346	11,113,150	955,459	.086
Benzol, crude and refined	Gal.	21,660,522	22,140,936	2,928,471	.132
Motor benzol	Gal.	95,526,695	93,767,208	8,384,863	.089
Toluol, crude and refined	Gal.	20,896,724	20,173,723	5,350,087	.265
Solvent naphtha	Gal.	5,725,918	5,255,014	988,411	.188
Xylol	Gal.	4,562,344	4,245,316	1,176,723	.277
Other light oil products	Gal.	8,130,103	5,522,858	431,390	.078
		[4] 156,502,306	162,218,205	20,215,404	.125
Naphthalene, crude and refined	Lb.	60,797,108	60,315,581	1,182,992	.020
Tar derivatives:					
Creosote oil, distillate as such	Gal.	15,401,597	14,900,402	1,452,879	.098
Creosote oil in coal-tar solution	Gal.	1,908,550	1,048,044	89,223	.085
Pitch of tar	Net tons	236,312	4,314	36,848	8.541
Other tar derivatives	....	....	....	1,310,612	......
Phenol	Gal.	104,738	110,181	43,272	.393
Sodium phenolate	Gal.	154,112	147,545	11,605	.079
Other products [5]	....	....	....	315,498	......
Value of all byproducts sold	....	....	....	[6] 132,124,838	......

[1] Includes products of tar distillation conducted by coke-oven operators under same corporate name· except, however, phenol and other tar acids produced at Clairton, Pa.
[2] Includes gas wasted and gas used for heating retorts.
[3] Refined on the premises to make the derived products shown, 182,030,795 gal.
[4] Total gallons of derived products.
[5] Ammonia thiocyanate, asphalt paint, carbolates, crude ferro cyanide, cyanogen sludge, extide covering, insecticides, light carbolic oils, pyridine oil, sodium carbolate, sodium prussiate, spent soda solution, sulphur brimstone, and vented vapors.
[6] Exclusive of the value of breeze production, which in 1937 amounted to $7,954,608.

Crude Naphthalene Production and Imports

(Data from U. S. Tariff Commission)

Year	Production: By Tar Producers	Production: By Tar Purchasers	Production: Total	Imports
	Thousands of Pounds			
1925	9,239	34,135	43,374	1,980
1926	7,747	45,166	52,913	6,963
1927	8,303	45,298	53,601	6,576
1928	12,182	35,180	47,362	19,926
1929	19,761	19,502	39,263	35,007
1930	12,640	18,617	31,257	27,667
1931	7,623	13,311	20,934	30,971
1932	4,632	8,961	13,593	27,002
1933	6,618	24,003	30,621	42,786
1934	10,743	27,179	37,922	47,995
1935	12,937	34,716	47,653	48,455
1936	37,552	51,984	89,536	39,806
1937	60,797	55,182	115,979	52,664

Statistics of the Gas Industry

(Source: Estimates of American Gas Association)

MANUFACTURED GAS	1938	1937	Per Cent Change
Sales (in M cu. ft.)			
Domestic	198,331,000	195,400,000	+ 1.5
House Heating	50,164,000	45,600,000	+10.0
Industrial and Commercial	108,507,000	107,433,000	+ 1.0
Miscellaneous	2,243,000	2,130,000	......
Total	359,245,000	350,563,000	+ 2.5
Revenue (Dollars)			
Domestic	$260,963,000	$256,853,000	+ 1.6
House Heating	31,964,000	28,539,000	+12.0
Industrial and Commercial	73,242,000	73,093,000	+ 0.2
Miscellaneous	1,545,000	1,480,000	......
Total	367,714,000	359,965,000	+ 2.2
NATURAL GAS			
Sales (in M cu. ft.)			
Domestic (Incl. House Heating)	350,143,000	359,294,000	− 2.5
Commercial	99,459,000	102,654,000	− 3.1
Industrial	581,451,000	681,978,000	−14.7
Electric Generation	172,500,000	170,567,000	+ 1.1
Total	1,203,553,000	1,314,493,000	− 8.4
Revenue (Dollars)			
Domestic (Incl. House Heating)	$244,063,000	$246,546,000	− 1.0
Commercial	47,381,000	48,152,000	− 1.6
Industrial & Electric Generation	127,418,000	146,534,000	−13.0
Total	418,862,000	441,232,000	− 5.1

NON-FERTILIZER PHOSPHATES

Considering volume alone 1938 was not a big year, but new products made up for that shortcoming

After climbing to a new record peak in 1937, non-fertilizer phosphates and phosphorus derivatives joined the downward procession last year and ended up with a definite falling off in total production. An official estimate of the size of the decrease is not yet available, but it is known that the amount of phosphate rock processed in the manufacture of this group of products in 1938 was well under the 496,129 long tons recorded by the Bureau of Mines for 1937. Several of the smaller producers, in fact, found it necessary to close down completely until profitable operations could be resumed.

But while the past year left much to be desired from the standpoint of both volume and earnings in the industry, present trade sentiment points to a generally optimistic feeling regarding the outlook for 1939. This is largely accounted for by two factors: first, the fairly rapid acceptance of several new phosphate products developed within the last two years, and second, the fact that general business conditions and other factors influencing the industry are decidedly more favorable than at the start of 1938. These, along with a gradual pick-up in sales and renewal contracts during the latter part of the year, are signs regarded as encouraging.

No new producers entered the non-fertilizer phosphates field during 1938, despite frequent early rumors that several new electric furnace plants were in the blue print stage. Electric furnace operations did increase, however, as the result of completion at the beginning of the year of the new electric furnace unit of the Victor Chemical Works near Mt. Pleasant, Tenn., and a smaller unit at Nichols, Fla., for production of elemental phosphorus by the Phosphate Mining Co. The new Victor unit replaces that company's blast furnace plant near Nashville, Tenn. The Monsanto Chemical Co. continued operation of its three large electric furnaces for elemental phosphorus at Columbia, Tenn., and the Agricultural Chemical Co. produced electric furnace phosphate products at South Amboy, N. J. There was an increased amount of elemental phosphorus used during the year in making various products for pharmaceutical and food purposes where higher concentrations and purity are required.

Among the new industrial phosphate products which were announced or advanced during 1938, perhaps the most outstanding is tetra sodium pyrophosphate, used in cleaning operations and as an ingredient in soaps. This compound has been found to show noticeably superior watersoftening and emulsifying properties. First announced in 1937, it is now being made by several companies and has meant increased production facilities and an important new outlet for phosphoric acid. A new plant for its manufacture is just being put into operation by the Monsanto Chemical Co. in East St. Louis, Ill. A similar product, tetra potassium pyrophosphate, was made available in 1938, as was also tetraphosphoric acid, a new high strength phosphoric acid which shows possibilities of use as a pickling acid for steel.

Phosphoric anhydride (phosphorus pentoxide), first introduced as an industrial chemical in 1937, is another product which required additional production facilities during 1938. Also of commercial interest is a new anhydrous mono calcium phosphate which contains a stabilizing element to prevent it from forming the monohydrate when exposed to the atmosphere. Its use is in baking powders.

(Please turn to page 129)

Domestic Consumption of Phosphate Rock

(Based on Bureau of Mines figures)

	Long tons of rock					
Uses	1932	1933	1934	1935	1936	1937
Superphosphates	858,657	1,416,441	1,561,066	1,705,215	1,768,677	2,391,245
Direct fertilizer	26,700	35,187	47,403	57,339	66,791	129,655
Undistributed [1]	7,355	2,286	5,877	1,106	2,453	16,607
Total fertilizer	892,112	1,504,914	1,614,346	1,763,660	1,837,921	2,537,507
Non-fertilizer [2]	222,828	244,302	306,853	272,032	354,299	496,129
Total	1,115,540	1,749,216	1,921,199	2,035,692	2,192,220	3,033,636
Non-fertilizer as per cent of total	20.0	14.0	16.0	13.3	16.1	16.3

[1] Includes phosphatic material used in manufacture of concentrated fertilizers, in pig-iron blast furnaces, as filler in asphalt mixtures, as foundry facings and in production of calcined phosphate.

[2] Includes phosphoric acid, phosphates and ferrophosphorus.

MOST RECENT CENSUS DATA

FERTILIZERS, Cont'd	1937	1935
Potash superphosphate,		
Tons	225,589	142,076
Value	$4,458,662	$2,680,679
Superphosphates, not ammoniated [1]		
Total production, tons	[2] 5,003,776	3,674,356
Made for sale, tons	2,641,640	1,754,777
Value	$27,566,881	$16,489,121
Made and consumed, tons	[3] 2,362,136	[3] 1,919,579
Fish scraps, tons	95,043	114,124
Value	$3,477,375	$2,912,937
Bone meal, tons	48,952	56,313
Value	$1,113,825	$1,414,115
Ammoniated superphosphates [4]		
Tons	47,010	41,278
Value	$729,967	$608,661
Other ammoniated fertilizers (non-potash), tons	23,347	19,763
Value	$354,233	$445,026
Other fertilizers, tons	210,629	129,868
Value	$4,837,859	$2,998,253

[1] Including concentrated phosphates; basis 16 per cent available phosphoric acid. [2] In addition 37,501 tons of triple superphosphate (44 per cent P_2O_5) was produced by Tennessee Valley Authority. [3] Not included in tonnage figure under "total fertilizer" above. [4] Including urea and ammonium nitrate solutions.

GLASS AND GLASSWARE

Aggregate value	$354,379,496	$277,626,998
Flat glass, value	100,938,681	68,266,602
Glassware, value	86,441,842	67,442,258
Glass containers, value	160,646,202	124,492,570

GLUE AND GELATINE

Aggregate value [1]	$41,701,252	$25,444,500
Glue, total value	30,555,805	17,245,792
Animal, pounds	127,842,264	90,283,081
Value	$17,789,697	$9,215,364
Vegetable, pounds	229,995,918	126,792,581
Value	$8,621,874	$5,204,473
Casein, pounds	7,982,056	5,873,943
Value	$1,072,395	$668,282
Flexible and fish [2]		
Pounds	15,873,966	13,790,191
Value	$2,411,581	$2,157,673
Gelatine, total pounds	29,493,928	23,830,325
Total value	$11,145,447	$8,198,708
Edible, pounds	22,020,617	
Value	$7,789,419	
Inedible and photographic [2]		23,830,325
Pounds	7,473,311	$8,198,708
Value	$3,356,028	

[1] Includes an indeterminate amount of duplication due to the use of animal and vegetable glue in the manufacture of flexible glue. [2] Figures combined to avoid disclosing approximations of the output of individual manufactures.

GREASE AND TALLOW [1]

Aggregate value	$63,684,062	$50,863,270
Grease (including soap stock), pounds	333,569,737	298,390,994
Value	$21,462,217	$18,940,698
Tallow, total pounds	568,034,827	515,742,320
Total value	$42,221,845	$31,922,572
Edible, pounds	62,352,668	74,135,254
Value	$4,886,448	$4,914,566
Inedible, pounds	505,682,159	441,607,066
Value	$37,335,397	$27,008,006

[1] Not including lubricating greases.

GUM TURPENTINE AND ROSIN

	1937–38 [1]	1935–36 [2]
Turpentine, total barrels (50 gals.)	518,454	497,000
Quantity and value reported		
Barrels	515,092	428,668
Value (at the still)	$7,425,520	$8,750,125
Quantity only reported		
Barrels	3,362	68,332
Rosin, total barrels (500 lbs. gross) [3]	1,709,157	1,647,000
Quantity and value reported		
Barrels	1,642,594	1,464,951
Value (at the still)	$21,175,211	$10,135,990
Quantity only reported		
Barrels	66,563	182,049

[1] Crop year ended March 31, 1938. [2] Crop year ended March 31, 1936. [3] Exclusive of reclaimed gum rosin reported as follows: 1947-38, 26,271 barrels; 1935-36, 54,187 barrels.

(Continued next page)

SYNTHETIC ORGANIC CHEMICALS

Several changes in the acetic acid situation attracted more than usual interest in 1938

SYNTHETIC ORGANIC CHEMICALS, although failing to make the spectacular showing characteristic of the industry for the past five years, may be said to have held up fairly well in the face of a trying year. Production was down slightly from 1937 levels. As was the case in many industries, business was slow the first half and good the last half of the year.

Technical developments with far-reaching significance occurred in the fields of synethic resins and fibers and they are discussed elsewhere in this issue. Chemical specialties and petroleum chemicals were also active as usual.

Petroleum chemicals especially have captured the spotlight in recent years. Ever increasing numbers of compounds which were formerly laboratory curiosities are now being produced in commercial quantities from petroleum. Some of them are: allyl alcohol, methallyl alcohol, heptanone, allyl chloride, methallyl chloride, isocrotyl chloride, trichloropropane, diallyl ether, dimethallyl ether, glycerine monochlorohydrin, glycerine dichlorohydrin, epichlorohydrin. Many others are available in laboratory quantities that existed only on paper heretofore. A process for the manufacture of glycerine from petroleum has been announced within the year. Although no substantial amount of glycerine is being made this way, it is understood that a small commercial plant has been producing for some time. All this information seems to point to the fact that the petroleum industry is becoming more and more a chemical manufacturing industry and the trend in this direction will undoubtedly continue.

Acetic Acid

Because there has been a marked shift in the balance between production, imports and consumption and also a number of important changes in the factors that make up production, acetic acid is receiving a greater than usual amount of attention this year. In discussing these changes we shall, as usual, consider acetic acid and its derivatives (acetic anhydride, ethyl and butyl acetate, etc.) as a group and report data on the basis of the acetic acid equivalent of the group. The reason for this is, of course, that many of the derivatives are now made directly without going through the acetic acid stage.

Consumption—Several factors combined to cause a 20 per cent drop in consumption. First of all, lacquer sales fell off tremendously—about 30 per cent—thereby cutting consumption of amyl, butyl and ethyl acetates. Secondly, one of the large automobile manufacturers switched from nitrocellulose to synthetic resin lacquers, depleting further the requirements for acetates. The third factor was a drop in cellulose acetate consumption in both rayon and plastics which, though considerably less than lacquer, carried a lot of weight. Considering these factors, *Chem. & Met.* estimates placed 1938 consumption of acetic derivatives at 163 million pounds

Production and Consumption of Acetic Acid and Its Derivatives, Basis 100 Per Cent Acid

Year	Production (Millions of pounds)			Imports	Apparent consumption
	From calcium acetate	By other methods	Total		
1927	86.9	12.5	99.4	12.1	111.5
1928	92.3	20.0	112.3	18.3	130.6
1929	85.3	43.1	128.4	27.6	156.0
1930	45.2	44.6	89.8	18.9	108.7
1931	33.5	46.1	79.6	13.7	93.3
1932	22.9	43.3	66.2	14.6	80.8
1933	25.4	64.2	89.6	34.0	123.6
1934	27.0	85.2	112.2	30.1	142.3
1935	42.7	116.5	159.2	35.1	194.3
1936	35.8	139.9	175.7	28.4	[1] 202.6
1937	20.6	156.6	177.2	31.7	[1] 208.7
1938 [2]	15.0	142.0	157.0	6.3	163.3

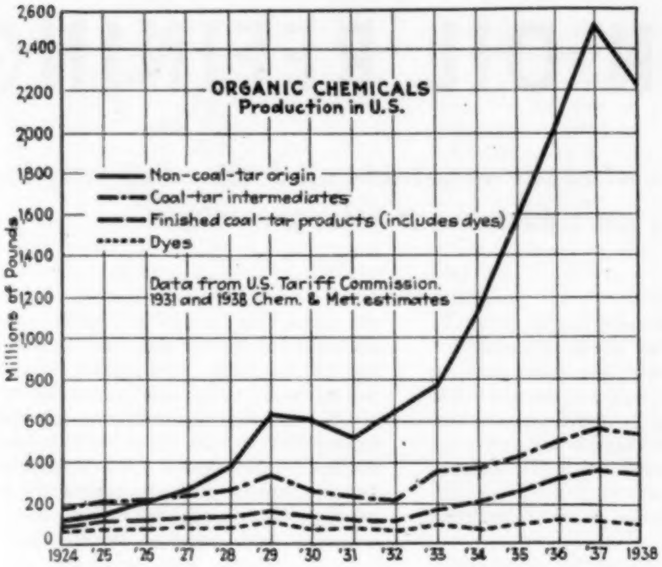
[1] Adjusted for relatively small exports.
[2] Chem. & Met. preliminary estimates, subject to revision. Data for all other years from United States Tariff Commission.

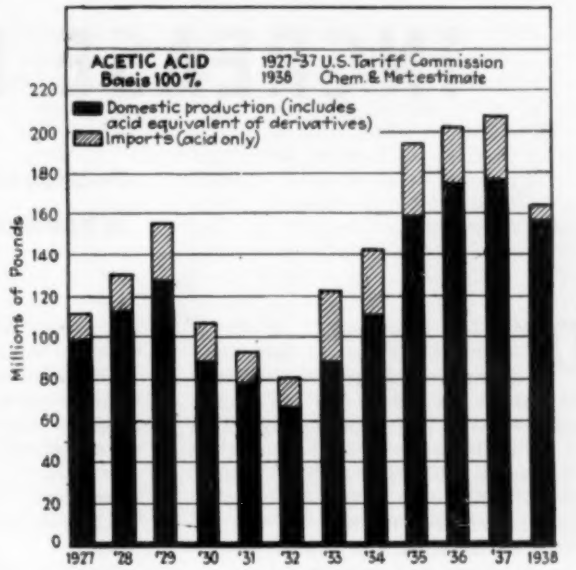
Production and Sales of Dyes and Organic Chemicals

(Data from U. S. Tariff Commission.)

	1925-30 average	1936	1937	Increase 1937 over 1936
Coal-tar chemicals				
Intermediates:				
Production......1,000 lb	267,492	509,706	575,893	13.0
Sales......1,000 lb	109,133	223,119	242,194	8.5
Sales value......1,000 dol	22,408	31,806	35,639	12.1
Finished coal-tar products:[1]				
Production......1,000 lb	138,078	[2] 336,348	[3] 371,124	10.3
Sales......1,000 lb	133,964	[2] 287,276	[3] 313,797	9.2
Sales value......1,000 dol	65,027	[2] 120,765	[3] 127,414	5.5
Dyes —				
Production......1,000 lb	94,003	119,523	122,208	2.2
Sales......1,000 lb	92,207	117,573	118,010	.4
Sales value......1,000 dol	39,428	63,686	64,531	1.3
Medicinals —				
Production......1,000 lb	4,508	12,034	14,800	23.0
Sales......1,000 lb	4,106	10,079	11,989	19.0
Sales value......1,000 dol	7,464	9,763	11,496	17.8
Flavors and perfume materials —				
Production......1,000 lb	3,966	3,481	4,348	24.9
Sales......1,000 lb	3,919	3,437	3,899	13.4
Sales value......1,000 dol	2,901	3,220	3,967	23.2
Coal-tar resins —				
Production......1,000 lb	[4] 24,442	[2] 117,302	[3] 141,099	20.3
Sales......1,000 lb	[4] 22,135	[2] 86,214	[3] 108,284	25.6
Sales value......1,000 dol	[4] 7,756	[2] 17,056	[3] 20,165	18.2
Non-coal-tar chemicals				
Production......1,000 lb	379,972	2,041,456	2,523,893	23.6
Sales......1,000 lb	264,006	1,034,921	1,168,058	12.9
Sales value......1,000 dol	44,499	105,832	119,375	12.8

[1] Includes color lakes, rubber chemicals and miscellaneous coal-tar products not shown separately.
[2] Does not include resins from coumarone and indene, hydrocarbons, styrol, and sulfonamides.
[3] Does not include resins from adipic acid, coumarone and indene, hydrocarbons, styrol, succinic acid and sulfonamides.
[4] 1927–30 average.





(basis 100 per cent acid). This compares with 208.7 million pounds consumed in 1937.

Imports—Suffering a decline of more than 80 per cent, imports form an interesting part of the overall picture. Due primarily to a falling market and increased productive capacity in the United States, foreign acetic acid accounted for only 6.3 million pounds in 1938 as compared with 31.7 million pounds in 1937. Since imports have been steady at 30-35 million pounds for the five years preceding 1938, this tremendous decline is significant. It may foreshadow the end of a U. S. demand for foreign acid.

Production—The estimate for 1938 domestic production is 157 million pounds as compared with 177 million pounds in 1937—a decline of only 11 per cent. In the face of the much larger decline in consumption, this was a creditable showing and was attained only by shifting import business to domestic producers.

As was expected, the hardwood distillers bore the brunt of the consumption drop, producing only 43 million pounds, compared with 60 million in 1937. Two-thirds of the 1938 yield from this source was produced by direct recovery whereas only one-third of the 1937 yield was produced in this way. Certainly the shift from acetate of lime to direct acid recovery is gaining increased momentum. In 1936, 60 per cent of the industry's capacity was equipped for acetate of lime recovery, but now the ratio has been reversed and in 1938, 60 per cent of the 2,580 cords capacity was equipped for direct recovery. At least one plant is planning to change over to direct recovery in 1939.

Synthetic production tells another story. The industry, if down at all from 1937, does not show a decline of more than a few per cent—estimated at about 2 or 3. Acetic anhydride, especially, has gone forward by leaps and bounds. In fact it is this part of the industry that supplied the consumption previously imported from Canadian producers.

Two large consumers of acetic acid became producers in 1938. One had already produced substantial quantities from wood but installed additional capacity for production from alcohol. Neither of these new plants produced substantial quantities in 1938, but they are expected to be important factors in the future. A third large consumer will probably produce acid or anhydride soon. Some chemical companies on the Pacific Coast await only a nearby market for acid to begin producing. They may get that market in the form of large rayon mills in the Pacific Northwest in not so many years.

(Please turn to page 132)

MOST RECENT CENSUS DATA

INSECTICIDES

	1937	1935
Disinfectants and insecticides, total value	$41,934,415	$37,945,785
Agricultural insecticides and fungicides		
Total value	$17,800,118	$16,543,840
Calcium arsenate		
Pounds	37,001,959	43,295,354
Value	$1,879,253	$2,322,394
Lead arsenate		
Pounds	63,291,440	52,145,851
Value	$5,540,885	$4,173,462
Lime-sulphur, dry		
Pounds	4,366,090	8,398,926
Value	$340,688	$425,470
Lime-sulphur solution		
Gallons	10,864,924	10,165,903
Value	$1,013,239	$990,572
Paris green		
Pounds	1,834,340	2,638,210
Value	$336,152	$489,427
Sulphur dust		
Pounds	19,365,392	
Value	$534,054	
Other agricultural insecticides and fungicides, including nicotine sulphate		$8,142,515
Value	$8,155,847	
Household insecticides and repellants, total value	$17,819,945	$13,302,727
Boiler compounds, value	4,318,720	5,882,981
Insulating compounds		
Value	1,982,952	
Household ammonia, value	869,740	
Household dyes, value	3,274,961	
Treating compounds, value	5,290,873	24,633,836
Waterproofing compounds		
Value	1,221,231	
Other compounds, value	36,239,776	

LIME

Aggregate tons	3,716,820	2,567,709
Value	$26,664,903	$18,972,072
Quicklime, tons	2,143,517	1,473,991
Value	$14,847,633	$10,403,914
Hydrated lime, tons	1,119,437	840,724
Value	$9,698,984	$7,101,372
Agricultural lime, tons	453,866	252,994
Value	$2,118,286	$1,430,913

LINSEED OIL, CAKE, AND MEAL

Aggregate value	$90,356,528	$60,264,331
Linseed oil [1]		
Pounds	638,171,128	483,025,310
Value	$59,848,229	$43,271,858
Cake and meal [1]		
Tons	587,832	470,760
Value	$21,421,083	$13,387,496

[1] These figures represent production in the Linseed oil industry alone and therefore do not cover the output of linseed oil, cake, and meal made as secondary products by establishments classified in other industries, which in 1937 amounted to 24,493,358 pounds of oil, valued at $2,259,600, and 19,286 tons of cake and meal, valued at $681,307. The combined production of linseed oil, was as follows; 1937, 665,098,850 pounds; 1935, 502,043,424 pounds.

PAINTS, PIGMENTS AND VARNISHES

Aggregate value	$552,595,703	$423,168,015
Dry colors, and pigments		
Total value	117,199,750	87,012,373
White lead (basic carbonate and sulphate)		
Pounds	144,313,029	117,570,732
Value	$9,450,759	$5,871,441
Lead oxides		
Total value	18,854,145	11,720,159
Litharge, made for sale		
Pounds	165,628,019	150,848,057
Value	$12,102,184	$7,733,737
Consumed where made		
Pounds	44,216,684	14,741,771
Red lead, minium, and other oxides, pounds	90,223,322	67,192,095
Value	$6,751,961	$3,986,422
Zinc oxides, pounds	321,889,816	255,678,214
Value	$15,316,173	$13,071,090
Lithopone, pounds	325,099,884	322,639,266
Value	$13,760,312	$14,207,118
Iron oxides, (natural and synthetic), pounds	128,891,324	112,423,238
Value	$4,067,840	$3,079,206
Other oxides, pounds	328,138,379	[1]
Value	$22,458,369	
Other mineral colors [3]		
Pounds	152,105,207	[3] 275,200,997
Value	$6,688,338	[3] $20,255,865

(Continued next page)

INCREASE IN OIL REFINING

Production of crude vegetable oil declined slightly but refined oils were turned out in larger volume

DOMESTIC production of crude vegetable oils for the first three-quarters of last year ran considerably above the output for the comparable period of 1937. But the large crush in the final quarter of 1937 brought the total up to 3,071,041,875 lb. as against 3,047,075,383 lb. for 1938. As was to be expected, crude cottonseed oil was far ahead of the other oils from a production standpoint and accounted for more than 55 per cent of the crude output last year compared with approximately 53 per cent in 1937. The larger supply of cottonseed combined with the excellent consuming demand for refined oil over the greater part of the year accounts for the enlarged operations at cottonseed oil plants.

Linseed oil, on the other hand, was adversely affected by the drop in production of paints, varnishes, lacquers, floor coverings, and printing ink. The decrease in output also was heightened by the fact that mill schedules were planned with a view to reducing the carryover of oil and the inventory position was improved so that crushing was resumed on a larger scale in the final quarter of the year.

Price considerations were a factor in holding up production of coconut oil and the supply of domestic-made oil amounted to 286,850,169 lb. which was close to 8 per cent higher than the 1937 total of 266,419,787 lb. As imports of coconut oil also were higher it is evident that the gain in domestic production was not an adjustment forced by an inadequate supply of foreign-made oil.

The trend toward larger consumption of domestic oils was one of the highlights in the year's development. Peanut oil offered an example with offerings amounting to 77,382,286 lb., a gain of more than 50 per cent over the 50,724,281 lb. produced in the preceding year.

Soybean oil made an exceptional showing last year and appears destined to take higher ranking in future years. With the oil holding a position in manufacturing lines and with its increased favor in the edible field, there seems to be good reason to look for more extensive planting of soy beans in this country and a corresponding gain in the amount of oil produced. Production of crude soy bean oil last year made a new record with an output of 322,067,147 lb. or approximately 66 per cent more than the 194,133,315 lb. produced in 1937.

China wood oil went through the year with the primary markets in the same unsettled condition which were noted in the preceding year. Yet shipments from China came forward in sufficient volume to take care of consuming requirements and build up a surplus so that the carry-over of stocks into the new year was larger than that of Jan. 1, 1938.

Operations at vegetable oil refineries were speeded up last year and the total amount of refined oils produced was more than 13 per cent higher than in the preceding year, the totals being 2,482,098,414 lb. for 1938 and 2,103,568,476 lb. for 1937. Comparable data for the two years would bring down the 1938 relative standing somewhat as complete figures for refining palm and babassu oils are not included in 1937 compilation. All the major oils contributed to the good showing made by refined oils as increases were reported for cottonseed, peanut, coconut, and soybean. Palm oil also was refined in larger volume last year but palm-kernel oil was of less importance both in the crude and refined state. A review of the statistics for refined oils again picks out soybean as the one which registered the largest relative growth, the figures showing 242,861 thousand pounds for 1938 and 133,473 thousand pounds for 1937. Coconut oil also made a favorable showing not only in respect to volume of output but also in passing into consumption in a larger way. This was in contrast to coconut oil which was turned out in a larger way than in 1937 but consumption fell off nearly 15 per cent in the year. Consumption of refined peanut oil increased moderately with large gains in the disappearance of coconut and soybean oils.

Market prices for oils had been on a downward trend from the early part of 1937 and while moderate recoveries were staged in the first quarter of last year, the curve held on a declining line throughout the last half of last year. Large supplies and keen competition were

Production, Consumption and Stocks of Vegetable Oils

	Production		Consumption		Stocks		
	1938 lb.	1937 lb.	1938 lb.	1937 lb.	Dec. 31, 1938 lb.	Dec. 31, 1937 lb.	Dec. 31, 1936 lb.
Cottonseed, crude	1,682,991,100	1,628,672,352	1,706,539,803	1,562,674,540	175,376,976	200,643,988	143,385,529
Cottonseed, refined	1,564,829,316	1,450,319,085	1,435,586,447	1,573,248,783	563,794,479	447,576,407	427,767,606
Peanuts, crude	77,382,286	50,724,281	71,011,375	58,461,980	7,564,228	4,311,751	12,103,948
Peanuts, refined	66,698,101	64,494,445	58,150,292	57,130,890	18,793,911	19,163,280	16,084,750
Coconut, crude	286,850,169	266,419,787	578,155,325	453,125,749	202,301,429	165,993,655	59,551,067
Coconut, refined	315,327,136	268,067,067	292,313,831	241,965,550	13,331,925	10,542,683	15,457,567
Corn, crude	134,874,481	126,095,341	144,625,456	156,160,324	14,726,115	8,912,271	11,635,556
Corn, refined	131,099,028	140,107,224	59,639,405	67,765,022	12,308,742	8,889,264	12,875,656
Soybean, crude	322,067,147	194,132,315	275,258,158	158,118,550	49,522,064	44,897,441	20,303,343
Soybean, refined	242,861,377	133,472,517	217,222,545	153,774,524	24,727,916	16,508,560	12,301,564
Olive, edible	3,122,982	....	2,990,120	3,295,509	5,013,042	2,467,861	4,009,321
Olive, inedible	....	....	4,249,080	5,643,383	861,873	1,725,290	2,483,364
Sulphur oil	....	....	15,360,096	18,357,736	12,422,862	8,550,323	7,023,651
Palm-kernel, crude	....	....	50,703,914	139,234,131	4,050,097	41,033,767	12,530,802
Palm-kernel, refined	18,284,719	26,202,260	19,539,194	31,005,188	2,261,489	787,595	1,720,917
Palm, crude	....	....	263,743,357	363,281,348	143,663,788	154,280,509	92,030,197
Palm, refined	123,473,912	....	120,895,140	....	18,759,219	....	....
Babassu, crude	29,502,633	35,678,179	29,523,665	41,062,096	1,462,820	3,186,047	1,912,625
Babassu, refined	19,504,825	....	22,507,677	....	277,700	....	....
Rapeseed	....	....	5,326,980	14,761,404	2,889,040	5,064,936	14,210,486
Linseed	440,614,136	665,098,850	298,921,178	374,468,861	141,785,426	191,386,262	117,267,639
China wood	....	....	87,648,700	120,361,467	61,408,141	48,484,511	28,872,045
Perilla	....	....	32,770,537	43,310,497	13,633,268	23,716,308	19,752,392
Castor	52,272,923	68,823,645	28,179,881	35,101,773	17,167,929	18,654,103	12,134,164
Sesame	....	....	6,695,772	37,667,407	205,440	5,484,841	11,572,852
All other	17,397,517	31,143,225	30,021,194	25,768,625	16,343,535	20,496,147	5,023,588

the factors in weakening values. With the exception of the drying oils, demand for oils did not drop last year to the same degree as the drop in general business. Price changes, therefore, followed more directly as a result of competitive selling. Values for oil also are influenced by the status of world markets and even cottonseed oil which is produced so largely in this country cannot ignore the parity of outside markets without incurring the danger of losing ground to the imported products. On different occasions in recent years, imported cottonseed oil has been quite important as a regulator of prices in domestic markets.

As a result of the larger refining activities there was a rise in stocks of refined oil at the close of the year and a lowering in stocks of crude oil. For all oils there was a stock increase last year of between 6 and 7 per cent with peanut, corn, coconut, soya and olive foots responsible for rise in crude stocks and cottonseed accounting for a large part of the increase in holdings of crude oil.

There were no arrivals of tung oil at Hankow from upcountry or any exports of the oil from that port made in December, according to a report from the American Consulate General at Hankow. Stocks of oil at Hankow the end of December amounted to 13,149 short tons, the same quantity on hand at the end of November. The Hankow market remained inactive with no transactions and no price quotations. It was also stated that no tung oil was known to be in the hands of the Japanese and no shipments of the oil were expected to be made in the near future. Radiograms stated that it was impossible to estimate with any degree of accuracy the receipts of tung oil reaching Hong Kong during December or any given periods, since arrivals are so irregular and by devious routes. There were no stocks of oil held by the Kwangsi Government at the end of the year, but estimates placed stocks of oil held by independent dealers at about 2,000 tons. November re-exports from Hong Kong totaled 11,056,969 lb. of which 9,777,422 lb. valued at U. S. $1,116,811 went directly to the United States and 1,279,547 lb. consigned to Great Britain, Germany, France, Norway, and Netherlands. The tung oil crop for 1938 was reported to be very good and indications point to a substantial increase in output of oil for 1939 on account of increased plantings made in the production area during recent years.

ACIDS AND SULPHUR

(Continued from page 107)

Reports during the year that a southern phosphate producer was experimenting with the DeJahn process for manufacturing sulphuric acid from gypsum appeared in the press, but the development apparently did not go far enough to arrive at conclusions regarding the feasibility of the process.

Investigations of methods for concentrating the sulphur dioxide in waste smelter gases and recovering elemental sulphur from such gases were continued by the U. S. Bureau of Mines. The experimental work on removal of sulphur dioxide from stack gases continued at the University of Illinois. Production of elemental sulphur from smelter gases at Trail, B. C., which was described in *Chem. & Met.* (Sept. 1938, p. 483), continued actively, with production of 13,533 long tons of sulphur in 1937 and production throughout 1938 at the rate of 100 tons per day. New construction at the Trail smelter will practically double this capacity. Work continued on the pyrites chlorination process at the Aldermac mine in Quebec and some small output of sulphur is believed to have been achieved. Aside from these developments, however, it appears that the recovery of elemental sulphur in the United States is still economically uninteresting.

This is the more so because of the drop in quoted sulphur prices from $18 at the mine to $16 late in 1938. This development followed the reduction of the Louisiana severance tax from $2 to $1.03 per ton of sulphur, to meet the Texas tax.

Reliable estimates of the production of other mineral acids during 1938 are not available. It is probable, however, that they followed the trend of chemicals and their production decreased somewhere in the range between 20 and 25 per cent. During 1937, according to the Census, total production of hydrochloric acid (basis 100 per cent) amounted to 121,473 tons, compared with 87,090 tons in 1935. Of this amount in 1937, 71,166 tons was made for sale, of which 53,027 tons was made from salt and 18,139 tons from chlorine and byproduct sources. Nitric acid reported by the Census in 1937 amounted to 175,860 tons (100 per cent basis), compared with 96,109 tons in 1935. Since the production of niter cake in 1937 was reported as 36,086 tons, this would indicate that approximately 18,400 tons of the nitric acid was produced by niter potting and 157,460 tons by ammonia oxidation. For the same year a production of 269,177 tons of salt cake, 31,934 tons of glaubers salt and 21,797 tons of anhydrous sodium sulphate was reported. The corresponding imports for 1937 were 220,176 tons of salt cake, 1,425 tons of glaubers salt and 15,308 tons of anhydrous sodium sulphate.

MOST RECENT CENSUS DATA

PIGMENTS, Cont'd	1937	1935
Fine color pigments (including vermilion and ultramarine), pounds	12,397,763	7,461,339
Value	$2,689,443	$1,542,289
Whiting, pounds	123,994,630	125,683,666
Value	$866,736	$833,366
Paints, total value	$200,846,090	$158,514,474
Paints in paste form		
Pounds	269,826,849	256,715,183
Value	$28,540,716	$23,267,858
Ready mixed and semi-paste paints, gallons	110,393,624	90,644,675
Value	$163,580,237	$129,167,748
Varnishes, lacquers, (including enamels and japans),		
Total value	$226,091,338	$171,185,727
Varnishes, value	64,730,411	50,025,338
Varnish stains		
Gallons	2,160,801	1,763,515
Value	$3,567,419	$2,932,682
Nitrocellulose (pyroxylin) products, total value	$72,361,461	$55,916,159
Clear lacquers, gallons	14,627,088	9,330,872
Value	$22,536,577	$12,862,302
Pigmented lacquers		
Gallons	14,923,736	11,768,682
Value	$28,468,925	$25,390,038
Thinners, gallons	24,145,856	18,591,545
Value	$15,630,598	$12,864,123
Lacquer bases and dopes		
Gallons	4,057,056	2,587,557
Value	$4,758,045	$3,149,486
Enamels, total value	$75,270,124	$55,097,453
Oil, ester-gum and natural resin, varnish base		
Gallons	24,201,976	20,422,809
Value	$39,029,634	$33,078,330
Synthetic resin, (oil, straight or modified)		
Gallons	18,196,244	11,040,123
Value	$36,240,490	$22,019,123
Drying japans and driers		
Gallons	3,522,010	1,850,588
Value	$2,946,870	$1,705,163
Baking japans		
Gallons	3,266,880	3,522,676
Value	$2,507,547	$2,151,304
Fillers, value	2,110,756	1,158,544
Putty, pounds	90,544,189	71,841,116
Value	$3,683,418	$2,871,865
Bleach shellac		
Pounds	14,639,005	12,524,732
Value	$2,664,351	$2,425,032

[1] Included in "other mineral colors" in 1935. [2] Includes zinc sulphide, barytes, and mortar colors. [3] Includes aluminum powders not mentioned in note 2.

PAPER AND PAPERBOARD

Aggregate value	$895,439,687	$656,115,565
Tons	12,837,003	10,479,095
Consumed where made (included above), tons	1,053,397	989,704
Value	$71,845,304	$61,506,577
Newsprint, tons	960,663	947,717
Value	$36,498,374	$33,353,967
Groundwood, printing and specialty papers, tons	492,972	274,154
Value	$30,378,097	$16,142,571
Book paper, tons	1,561,074	1,281,870
Value	$150,170,447	$112,608,975
Cover paper, tons	24,437	20,806
Value	$4,435,204	$3,710,430
Writing paper (fine) tons	578,147	507,325
Value	$87,271,592	$70,619,934
Wrapping paper, total—tons	2,053,387	1,632,054
Value	$179,734,517	$127,058,538
Sulphite, tons	678,329	421,111
Value	$60,963,724	$40,223,096
Kraft, tons	1,130,033	984,784
Value	$86,142,532	$66,179,671
Other, tons	245,025	226,159
Value	$23,628,261	$20,655,771
Tissue paper, tons	540,152	473,214
Value	$63,433,450	$46,235,141
Absorbent paper, tons	138,064	95,179
Value	$22,120,473	$15,911,243
Building paper, total tons	608,086	440,704
Value	$32,630,126	$19,449,767
Other paper, tons	77,985	110,182
Value	$11,427,872	$10,921,673
Boards, total tons	5,802,036	4,695,890
Value	$277,339,535	$200,103,326
Container boards, tons	3,167,550	2,358,093
Value	$134,403,314	$88,459,767
Liners, tons	2,144,568	1,601,189
Value	$95,626,113	$64,177,141
Chip (plain and test) tons	506,013	410,489
Value	$18,457,834	$11,948,682
Straw (for corrugated container use), tons	441,312	346,415
Value	$16,895,781	$12,333,944
Other container boards		
Tons	75,657	[1]
Value	$3,423,586	[1]

[1] Not recorded separately.

(Continued next page)

ROSIN PRODUCTS IMPROVED

Hydrogenated rosin and noncrystallizing gum rosin developed during the year

TWO outstanding developments in the naval stores industry last year, were the development of a hydrogenated rosin by one of the leading producers of gum and wood rosin and the evolution of a process to produce a noncrystallizing gum rosin by the U. S. Department of Agriculture.

The new hydrogenated rosin is described as retaining the characteristics of rosin but virtually eliminates the tendency to oxidize and become brittle and yellow with age. The process of hydrogenation has been patented. The final product is said to be lighter in color than any rosin heretofore on the market and the color is not affected by exposure to light. This development is regarded as an indication that the consuming field for rosins will be broadened because the elimination of the tendency to oxidize, lose color, and otherwise deteriorate makes it applicable in instances where formerly it could not be used.

The new noncrystallizing gum rosin is a natural rosin from Southern pine gum, which is said not to crystalize in ordinary usage. It is made only from the liquid part of the oleoresinous exudate of the living tree. Its preparation is based on a recent finding, that the semisolid mass which forms when the gum is allowed to stand contains most resin acids which later contribute to the crystallizing tendency of the rosin.

This mass is removed from the liquid part by simple straining or filtration through a light-weight muslin cloth. The straining must be entirely by gravity; mechanical filter pressures cannot be used, as the higher pressure causes some of the semisolid crystalline mass to liquefy and mix again with the liquid. The straining removes the crystalline part of the oleoresin, and by removing chips, bark, and finely suspended particles, permits the production of clean gum resin.

Semiplant scale tests are reported to have shown that production of the new rosin is commercially feasible. A public service patent covering the new product, making it available to anyone, has been applied for.

The conservation program acted as a stabilizer for the industry but the drop in general business affected the movement of both turpentine and rosin to domestic centers and as export trade also was of a declining nature, values were not able to be sustained and the trend was downward.

A report from France on the status of the French industry in November stated that there was no improvement in the domestic demand for turpentine and rosin during the month owing to the lack of sales to the principal consuming industries. Weather conditions were favorable, which permitted satisfactory progress in the collection of the scrape crop. It is too early to secure any definite statement as to the possible yield of gum from the 1938 naval stores crop, as all of the gum has not been delivered to the stills. It was stated, however, that the quality of both turpentine and rosin was very good. Total exports of turpentine from France for the first 10 months of 1938 increased to 3.068 metric tons valued at 10,577,000 francs from 839 tons valued at 3,224,000 francs for the 10 months of 1937. Rosin exports also advanced, to 41,182 metric tons valued at 78,759,000 francs for the 1938 period from 28,927 tons valued at 58,626,000 francs for the same months of 1937.

Export trade in naval stores in this country last year was featured by declines in two directions. In the first place the amounts shipped abroad were considerably below those shipped in the preceding year and in the second place, the unit value was markedly lower. This combination resulted in a decided falling off in the dollar volume of exports, the totals being $12,329,000 for 1938 and $22,141,000 for 1937. The drop in volume was general throughout the naval store's commodities. Outward shipments of rosin last year amounted to 1,028,530 bbl. compared with 847,000 bbl. in 1937. Exports of turpentine were 10,655,000 gal. and 13,610,000 gal. in 1938 and 1937 respectively while exports of pine oil were reduced from 1,730,200 gal. in 1937 to 1,523,000 gal. in 1938.

Production of Rosin and Turpentine

	TURPENTINE			ROSIN		
	1938–39 Apr.-Sept. 6 mo.	1937–38 Apr.-Sept. 6 mo.	1937–38 Apr.-Mch. 12 mo.	1938–39 Apr.-Sept. 6 mo.	1937–38 Apr.-Sept. 6 mo.	1937–38 Apr.-Mch. 12 mo.
	(Bbl.-50 gal.)			(Bbl.-500 lb. gross)		
Gum	386,018	361,986	518,454	1,242,901	1,114,069	1,709,157
Reclaimed (Gum)	0	0	0	21,142	8,543	26,271
Steam Dist. Wood	57,045	70,086	136,292	364,592	421,328	803,538
Sulphate Wood	17,823	9,386	38,500	6,572	0	[2]223,000
Dest. Dist. Wood	2,484	3,421	7,085	0	0	0
Total	463,370	444,879	700,331	1,635,207	1,543,940	2,561,966

Reported Consumption of Turpentine and Rosin
(Combined Gum and Wood Products)

	TURPENTINE			ROSIN		
	1938–39 Apr.-Sept. 6 mo.	1937–38 Apr.-Sept. 6 mo.	1937–38 Apr.-Mch. 12 mo.	1938–39 Apr.-Sept. 6 mo.	1937–38 Apr.-Sept. 6 mo.	1937–38 Apr.-Mch. 12 mo.
	(Bbl.-50 gal.)			(Bbl.-500 lb. gross)		
Abattoirs	0	0	0	797	1,174	1,635
Adhesives and plastics	255	231	638	6,349	9,318	17,596
Asphaltic products	0	2	0	595	862	1,060
Automobiles and wagons	205	318	544	152	361	603
Chemicals and pharmaceuticals [1]	7,064	18,646	31,275	44,166	68,416	119,246
Ester gum and synthetic resins	0	0	0	43,365	58,258	111,812
Foundries and foundry supplies	296	500	750	3,169	11,031	15,227
Furniture	263	299	559	4	51	37
Insecticides and disinfectants	256	275	526	2,589	2,626	4,060
Linoleum and floor covering	32	43	67	11,931	17,672	27,482
Matches	0	0	0	888	1,094	2,126
Oils and greases	24	110	45	9,836	12,570	24,498
Paint, varnish and lacquer	27,450	34,837	55,985	62,081	83,835	136,897
Paper and paper size	0	7	0	151,438	202,702	340,200
Printing ink	204	94	271	6,092	5,196	12,763
Railroads and shipyards	1,416	3,456	4,421	375	499	290
Rubber	54	94	138	1,356	1,587	2,722
Shoe polish and shoe materials	2,845	6,439	10,726	4,752	3,728	8,176
Soap	100	3	9	126,034	115,864	272,820
Other industries	861	924	1,636	2,516	3,088	4,397
Total industrial reported	41,325	66,278	107,599	478,485	509,932	1,103,647
Not accounted for [2]	183,392	170,437	335,127	135,017	83,917	88,087
Apparent U. S. consumption	224,717	236,715	442,726	613,502	683,849	1,191,734

[1] Includes turpentine and rosin consumed in producers' plants in the production of unclassified derived products.

[2] Principally unreported distribution of turpentine through retailers who sell in small quantities to ultimate consumers, and unreported industrial consumption of rosin; also rosin distributed through retailers who sell in small quantities to ultimate consumers.

TREND IN PIGMENTS

Whitening power and special chemical effect influence consuming demand

RECENT developments in the white pigment industry lead to the conclusion that consuming outlets are becoming more conscious of a definite division between those which are used primarily for their whitening power and those which are used primarily because of special chemical or physical effects. Zinc sulphide and titanium pigments are in the first group and zinc oxide, leaded zinc oxide, and the white leads are in the second group.

Sales of white lead in oil and of leaded zinc oxide made comparatively good showings last year but in the long run, the probability favors faster relative growth for the pigments of the first group. This trend may be exaggerated during depression periods and disguised or counteracted during good times. It is the result of increasing knowledge on the part of compounders generally. Both zinc oxide and white lead are relatively expensive and their use may be restricted to applications where their special properties are required.

On the other hand, the use of whitening power units is steadily increasing. If the tons of each pigment sold are multiplied by an index which gives its relative whitening power per ton, based on one ton of lithopone equals one unit of whitening power, it will be found that whereas 1937 was something like 8 to 9 per cent less than 1929 in tonnage sold, it was more than 20 per cent ahead in whitening power units sold.

The growing importance of titanium pigments continues to be outstanding in the whitening power group. The tendency towards the use of pure titanium rather than letdown pigments is noticeable and is expected to continue even though a substantial market for the factory-made mixtures seems assured.

In connection with the rising trend in titanium production, it may be mentioned that one of the largest paint manufacturers is reported to have acquired a site for a new titanium plant. Another plant which had not been in operation in 1937 came into regular production last year under new ownership.

In former years, prices for white pigments were closely related and a change in one generally resulted in an adjustment all along the line. This still holds for zinc sulphide versus titanium dioxide but only slightly for zinc oxide and white lead versus the whitening power group. In June, for instance, titanium dioxide was reduced from 16c to 15c a lb. The reduced titanium pigments, zinc sulphide, and the various lithopones promptly followed suit but white lead and zinc oxide were unchanged.

Titanium pigments have since been again reduced in price and this may be an indication of a trend since each reduction brings the probability of an increase in consumption. It happens that in many most promising fields for titanium, particularly in the paper industry, price is a very important factor and, at present, price is close to the border line where it will pay to use more pigment and cheaper base material.

Estimated Sales of Titanium Pigments in 1937

	Tons[1]
Paint	83.000
Paper	12,000
Rubber	8,000
Floor coverings	8,000
Leather dressings, etc.	2,000
Exports	2,000
Miscellaneous	11,000
Total	126,000

[1]Divided: 49,000 tons pure; 77,000 tons reduced.

Sales of lead and zinc pigments in 1938 on the whole were considerably under totals for the previous year, according to the Bureau of Mines. White lead, dry and in oil, and leaded zinc oxide fared better than the others, showing declines of only 1 and 5 per cent, respectively, from totals for 1937. Sales of leaded zinc oxide in 1937 were at relatively the peak level of 1936, so that in 1938 this pigment was far ahead of all others in relation to previous high record outputs.

Of the lead pigments, white lead in oil accounted for the only increase, sales of this product rising 9 per cent. Sales of dry white lead, however, declined 23 per cent so the total for the two classes was 1 per cent below that for 1937. Other decreases were: red lead 15 per cent, litharge 21 per cent, basic lead sulphate 33 per cent and orange mineral 37 per cent. The figures for basic lead sulphate do not present a true picture of the activity in this pigment. Its production has increased considerably in past years, but much of increased tonnage has been for manufacture of leaded zinc oxide and the amount so used has been eliminated in order to avoid duplication of metal content in reporting

(*Please turn to page 129*)

MOST RECENT CENSUS DATA

PULP

	1937	1935
Aggregate, tons	6,757,842	5,032,299
Value	$244,667,297	$165,322,871
Wood pulp, total	6,617,184	4,925,669
Value	$227,796,971	$149,981,900
Mechanical, tons	1,600,667	1,355,819
Value	$30,315,251	$24,972,104
Sulphite, total tons	2,162,771	1,579,567
Value	$111,029,418	$70,425,758
Unbleached, tons	814,102	634,947
Value	$31,827,729	$21,909,660
Bleached, tons	1,348,669	944,620
Value	$79,201,689	$48,516,098
Sulphate, total		
Tons	2,160,826	1,467,749
Value	$60,552,279	$36,008,886
Unbleached, tons	1,945,676	1,340,288
Value	$52,211,166	$31,213,254
Bleached, tons	215,150	127,461
Value	$8,341,113	$4,795,632
Soda, tons	507,548	
Value	$23,465,719	[1] 485,102
Semi-chemical and other wood pulp, total tons	132,521	[1] $18,165,468
Value	$1,748,316	

[1] Soda and semi-chemical pulp only. Combined to avoid disclosing production reported by an individual establishment.

PETROLEUM REFINING

	1937	1935
Aggregate value	$2,537,060,775	$1,830,394,443
Gasoline, gallons	22,626,325,189	18,505,867,347
Value	$1,447,688,118	$1,023,577,578
Naphtha, gallons	281,391,374	216,906,289
Value	$19,380,787	$13,223,238
Benzine, gallons	38,591,722	43,241,099
Value	$2,650,804	$2,577,185
Tops, gallons	[1]	41,657,567
Value	[1]	$1,223,787
Illuminating oils		
Gallons	2,508,045,150	2,194,731,494
Value	$123,681,070	$94,178,808
Fuel oils, gallons	19,243,713,721	15,905,205,577
Value	$512,904,099	$359,437,322
Partially refined oils sold for rerunning		
Total gallons	1,147,454,232	1,042,275,771
Lubricating oils		
Gallons	1,517,102,553	1,274,384,495
Value	$245,666,434	$186,533,605
Road oils		
Liquid asphaltic, gallons	481,135,078	406,967,817
Value	$16,417,605	$13,346,322
Other road oils, gallons	111,421,814	[2]
Value	$3,104,192	[2]
Residuum or tar		
Gallons	20,421,403	88,525,836
Value	$853,393	$1,696,440
Greases, gallons	61,925,798	49,918,651
Value	$17,215,900	$12,739,929
Paraffin wax		
Gallons	90,608,190	76,495,085
Value	$19,213,203	$14,446,776
Acid oil, gallons	57,633,349	94,257,589
Value	$1,015,991	$1,219,084
Asphalt, other than liquid asphalt, tons	2,971,038	2,153,619
Value	$31,352,147	$23,232,564
Petroleum coke		
Tons	1,327,238	1,443,856
Value	$5,048,049	$5,764,674
Liquefied petroleum gases		
Gallons	101,075,825	355,962,713
Value	$3,355,409	$7,256,124
Other refinery products		
Value	$48,787,183	$38,282,714

[1] Withheld to avoid disclosing approximations of data reported by individual establishments. Value included in value of "Other refinery products." [2] No data. Not called for separately prior to the census for 1937.

RAYON

	1937	1935
Products, total value	$254,697,216	$185,159,534
Yarns, pounds	321,680,725	257,557,347
Value	$204,790,613	$146,067,470
Finer than 125 denier		
Pounds	[1] 82,057,093	58,496,218
Value	$65,101,277	$42,776,701
125–150 denier, pounds	[1] 194,149,068	152,156,504
Value	$116,286,163	$80,790,324
Heavier than 150 denier		
Pounds	[1] 45,474,564	46,904,625
Value	$23,403,173	$22,500,445
Rayon staple fiber		
Pounds	20,244,258	
Value	$6,177,471	$32,509,123
Rayon waste, pounds	11,185,338	
Value	$1,117,360	

[1] A more complete breakdown was published for 1937 by the Bureau of the Census.

(*Continued next page*)

DROP IN CHEMICAL EXPORT TRADE

New products are developing consuming outlets in numerous countries abroad

EXPORT trade in chemicals and related products, including medicinals, toiletries, and soaps, aggregated \$156,000,000 in value during 1938, according to Department of Commerce estimates, which was a decline of around 13 per cent from the preceding year total and approximately the same as in the year 1936. During the 5-year period from 1934 to 1938, inclusive, our export trade in chemicals and related products recorded a value gain of 50 per cent, according to the preliminary statistics.

As in 1937, our export business in relatively new products continued to gain during the year just ended. Gases of various kinds; new paint and varnish products; chemical specialties used in the leather, textile, and other fields; new medicinals, pharmaceuticals, biologics, and toiletries—these and many other products, some of which are too new to export trade to be classified separately in our trade returns, are now going forward regularly to a score of foreign markets.

The small loss recorded in our exports of chemicals and related products during 1938 was due very largely to the lowered volume, and in some instances to lower price levels, for such products as naval stores, certain finished and crude coal-tar products and pigments. Exports of crude drugs, medicinals, pharmaceuticals, essential oils, chemical specialties, organic chemicals, ready-mixed paints, varnishes, lacquers, toiletries, and soaps were well maintained compared with 1937, and in some instances recorded gains.

Official figures place exports of chemicals as contained in Group 8, at a valuation of \$117,432,803 for the first 11 months of 1938 which compares with \$139,447,201 for the calendar year of 1937.

Referring to the divisions within Group 8 it is found that coal-tar chemicals lost ground in the export trade last year. Coal-tar intermediates dropped rather sharply as did dyes while outward shipments of benzol did not reach one-half of the total shipped in 1937.

Chemical specialties made an especially good record with 11 months shipments valued at \$26,707,231 or only a little more than \$800,000 below the 12 months total for the preceding year. In this group copper sulphate was prominent because of a gain over the 1937 shipments. Insecticides and fungicides in general found a good export market last year. Synthetic gums and resins may be included among the relatively new products which are of growing importance in foreign trade. Such shipments through November last year were reported at 6,459,765 lb.

In the industrial chemical division buying for foreign delivery was larger than in 1937 in acetic and much larger in acetic anhydride. Other organic acids and anhydrides lost ground. Boric acid improved its position to a noteworthy degree. Methanol fell far below the 1937 figure but butanol went out in considererably larger quantities. Acetone also was shipped out in a larger way. Aluminum was down but only moderately and a decided pick-up was reported for calcium chloride.

Potassium compounds, not including fertilizers, competed more favorably in outside markets but sodium compounds took a precipitous drop with borate shipments almost cut in two. Cyanide, bicarbonate, and phosphates ran counter to the trend and sold more freely. Caustic soda shipments ran heavy in the closing month of the year and brought the 12-month total up to a little over 200,000,000 lb. or about 4,500,000 lb. under the 1937 figure. Soda ash total bettered 102,000,000 lb. but this was over 7,000,000 lb. below the amount exported in 1937. Chlorine, which was in larger supply last year, was able to take a higher ranking in export business.

American exporters seeking information about the markets for their products abroad may avail themselves of a unique government service. Through its 34 foreign offices and the 252 American consulates located throughout the world, the Bureau of Foreign and Domestic Commerce will conduct individual foreign market trade surveys for American exporters.

These surveys may result in positive or negative action by the field officer in behalf of the exporter. If, after surveying the market, there is found to be a possibility for the sale of the exporter's product, the field officer may furnish the names of one or more potential distributors who have expressed an interest in the line. At the same time he will ask these distributors to write direct to the American firm.

In order to perform this service adequately, the field officer must have certain information about the American firm and its products. A form has been developed for this purpose. It requests, in addition to the name and address of the exporter, a statement as to his method of operation (either as a manufacturing exporter, export commission house or combination export manager); catalogues should be provided where available, otherwise descriptive literature of the product; the countries to be covered in the survey and the type of foreign representation desired (manufacturers' sales agent, importing wholesaler, commission merchant, or importing retailer) are to be specified; the selling terms of the exporter, including prices (if possible quoted c.i.f. foreign port), discounts, methods of payment desired, agent's commission and allowances asked for; the previous interest of the exporter in the territory is necessary for the field officer to do a good job; finally, general information is requested so that the potential distributor may know something about the American firm, year established, paid up capital, time engaged in export trade, financial references, cable address and codes used.

ALKALIS and CHLORINE

(Continued from page 209)

and of about 2 per cent in exports. Miscellaneous uses are believed to have dropped slightly less than 10 per cent and chemicals, 15.2 per cent. One of the largest consuming fields, rayon and cellulose film, experienced a production decline sufficient to decrease caustic consumption by 16.7 per cent.

A similar decline in caustic use was indicated for the lye industry which apparently took about 16.7 per cent less of this chemical. Slightly more of a decline, 18.3 per cent, is estimated for caustic usage in the textile industry. Soda pulp production declined to such an extent that the consumption of caustic in the pulp and paper field fell some 27.1 per cent, while rubber reclaiming suffered a loss estimated to be slightly in excess of 31 per cent. For the group, the decline in total caustic soda sales from 1937 to 1938 was of the order of 11.1 per cent.

No technical trends of significance were evident in the production of soda ash during 1938. In the production of caustic soda, there has been continued interest in the mercury cell as indicated in our last Annual Review number, and an installation of I.C.I. mercury cells has been completed by the Michigan Alkali Co. at Wyandotte, Mich. Likewise several installations of the Hooker Type S cell were completed during the year, including a large installation of 180 cells at Southern Alkali Corp.'s Corpus Christi plant (*Chem. & Met.*, June 1938, p. 296 and July, 1938, p. 354). Two smaller installations of this cell were completed at Champion Fibre plants at Houston, Tex., and Canton, N. C.

The previously mentioned report by the Federal Power Commission ("Power

Requirements in Electrochemical and Electrometallurgical and Allied Industries," Federal Power Commission, Washington, D. C., 1938, price $1.) contains some interesting information regarding electrolytic industries and their products. For example, it gives a breakdown of chlorine applications during 1936, crediting 30 per cent to the bleaching of pulp, 5 per cent to the bleaching of textiles, 51 per cent to the production of chemicals, 6 per cent to sanitation and 8 per cent to all other uses. For the period from 1929 to 1936, 87 per cent of the chlorine, on the average, was produced coincident with caustic soda and 13 per cent coincident with caustic potash, metallic sodium and electrolytic sodium carbonate. On July 1, 1937, according to this authority, the electrolytic chlorine capacity of the country was 467,000 tons of which 404,000 tons was in the electrochemical industries and 63,000 tons was in pulp and paper plants. The caustic soda capacity listed was 485,000 tons as of this date. The power requirement was given as 3,000 kw.-hr. per ton of chlorine, plus 400 kw.-hr. for pumping, lighting and material handling. Power requirements for the production of metallic sodium were listed as 9,300 kw.-hr. per ton of chlorine or 14,400 kw.-hr. per ton of sodium. The country's one metallic sodium plant is listed as having a direct-current supply of 21,760 watts, corresponding roughly to a capacity of 1½ tons of sodium per hour. The chlorine capacity of this plant is listed as 38,000 tons per year, less the small chlorine capacity of those plants producing sodium carbonate electrolytically.

NON-FERTILIZER PHOSPHATES

(Continued from page 121)

Prices of practically all non-fertilizer phosphorus compounds have remained unchanged throughout the year. An exception is to be noted in phosphoric anhydride, mentioned above, which was reduced from between 14 and 16 cents a pound to 11 cents in carloads. Other products, however, have shown no changes worth mentioning. Over the past several years, phosphate prices in general have steadily declined.

From the accompanying table it will be seen that non-fertilizer phosphates, reported on a rock basis, have gained steadily in volume from 1932 through 1937. For the latter year the rock used for these purposes amounted to around a half million tons. It is interesting to note that the rock consumed in fertilizer materials is keeping about an even pace with non-fertilizer consumption, although both progressed during the period shown at a greater rate than can be attributed entirely to the general recovery trend. Government aid to farmers has of course promoted the use of synthetic fertilizers, while new products and wider uses for established products have enabled non-fertilizer phosphates to show a better than average advance. Indications are that the approximate 5 to 1 ratio between these two divisions did not change appreciably during 1938.

The chief volume items in the non-fertilizer division during the year were mono- and disodium phosphate for water conditioning, calcium pyrophosphate and dicalcium phosphate for dentrifices, monocalcium phosphate for leavening in baked goods and tetra sodium pyrophosphate for cleaning powders.

The industry's research program for 1939 includes work on a variety of new products which point to increased significance of phosphates in fields not yet touched upon commercially. Increased attention is also being given to promoting production efficiency and further lowering costs, particularly in the electric furnace process. As yet, this process can compete with the acidulation method only where high purity and high concentration products are desired.

WHITE PIGMENTS

(Continued from page 127)

statistics for leaded zinc oxide. Approximately 5,500 tons of basic lead sulphate were used to increase the lead content of leaded zinc oxide in 1937 and a considerably higher tonnage for that purpose in 1938.

Leaded zinc oxide sales were only 6 per cent below the record high of 1936 and were 5 per cent below the total for 1937. Sales of lithopone declined 19 per cent and of zinc oxide 31 per cent from the totals for 1937.

Sales of zinc sulphate fell 29 per cent from those for 1937. The refusal of an important producer to supply reliable information makes it impossible for the Bureau of Mines to publish totals for zinc chloride. Available data, however, indicate that sales of this commodity dropped more precipituously than those of any other covered by this report.

Domestic lead and zinc pigments and zinc salts sold in the U. S., 1937–38

	1937 tons	1938 tons
Basic lead sulphate or sublimed lead:		
White	[1] 7,514	[1] 5,000
Blue	[1] 1,108	[1] 800
Red lead	33,931	28,700
Orange mineral	206	130
Litharge	83,902	66,300
White lead:		
Dry	32,661	25,100
In oil [2]	65,552	71,700
Zinc oxide	114,652	79,100
Leaded zinc oxide	40,343	38,200
Lithopone	154,771	124,900
Zinc sulphate	10,521	7,500

[1] Exclusive of basic lead sulphate used for the manufacture of leaded zinc oxide which is included in tonnages shown for that pigment.
[2] Weight of white lead only.

MOST RECENT CENSUS DATA

REFRACTORIES

	1937	1935
Nonclay, total value	$31,057,044	$21,290,232
Made as secondary products in other industries (included above), value	$3,720,272	$1,293,008
Carbon:		
Crucibles and retorts Value	$1,508,523	$1,035,644
Other carbon, value	$726,413	$452,095
Magnesite and chrome brick, Thousands	22,758	12,112
Value	$6,726,943	$3,424,726
Silica brick, thousands	198,156	149,621
Value	$11,712,993	$8,179,990
Refractory cement (nonclay):		
Silicon carbide cement, tons	724	
Value	$142,939	39,287
All other, tons	113,994	$944,155
Value	$2,132,061	
Other nonclay refractories	$8,107,172	$7,253,622

RUBBER

	1937	1935
Boots and shoes, value	$57,684,097	$48,261,613
Tires and tubes, value	$478,449,978	$374,264,436
Rubber goods other than tires, tubes, and boots and shoes, value	$345,763,255	$249,105,632
Salt, total value	$32,740,610	$29,720,004

SOAP

	1937	1935
Aggregate value	$271,577,234	$223,808,580
Made as a secondary product in other industries (included above), value	$13,699,695	$12,804,189
Bar soaps:		
Toilet soaps, pounds	300,610,753	352,976,104
Value	$62,805,065	$53,324,747
Laundry soaps		
White, pounds	488,979,981	420,524,270
Value	$28,192,491	$19,937,559
Yellow [1], pounds	633,441,319	713,540,726
Value	$33,195,616	$31,402,714
Granulated, powdered, and sprayed soaps, pounds	743,194,783	503,117,738
Value	$68,408,836	$45,283,702
Soap chips and flakes:		
Packaged, pounds	274,275,994	307,274,876
Value	$28,207,372	$25,615,958
Bulk, pounds	116,179,494	151,659,892
Value	$9,797,688	$10,713,357
Washing powders:		
Packaged, pounds	146,924,947	132,681,612
Value	$6,582,021	$5,535,464
Bulk, pounds	83,504,344	86,366,692
Value	$2,481,397	$2,210,182
Cleansers and scouring powders containing soap [2]:		
Packaged, pounds	157,039,241	106,233,597
Value	$6,254,838	$6,186,478
Bulk, pounds	21,307,024	37,353,855
Value	$917,323	$1,501,227

[1] Consumption of rosin used in the manufacture of soap in 1937 amounted to 75,450,320 pounds. No data available for 1935. [2] Produced by establishments classified in the Soap industry only.

BEET SUGAR

	1937	1935
Sugar, tons	1,296,210	1,186,448
Value	$99,991,185	$89,103,480
Molasses, sold or transferred to other factories for desugarization, tons	153,898	145,612
Value	$1,161,272	$995,181
Molasses, other than for desugarization, tons	93,786	87,924
Value	$1,070,351	$796,631
Beet pulp, tons	1,820,568	1,546,003
Value	$5,048,978	$4,185,397
Other products, value	$123,750	$79,115

CANE SUGAR PRODUCTION

	1937	1935
Sugar, tons	302,321	350,982
Value	$25,734,312	$23,110,766
Sirup [1], gallons	2,951,579	3,442,982
Value	$911,199	$863,589
Molasses, other than blackstrap [1], gallons	4,295,097	5,438,182
Value	$533,227	$663,906
Blackstrap molasses [1]		
Gallons	26,428,679	19,940,843
Value	$1,359,415	$1,174,952
Bagasse, for sale as such		
Tons	179,966	115,785
Value	$499,895	$278,733

[1] Made in the Cane Sugar Production industry only.

(Census data continued on page 139)

PRICE INDEXES REVISED

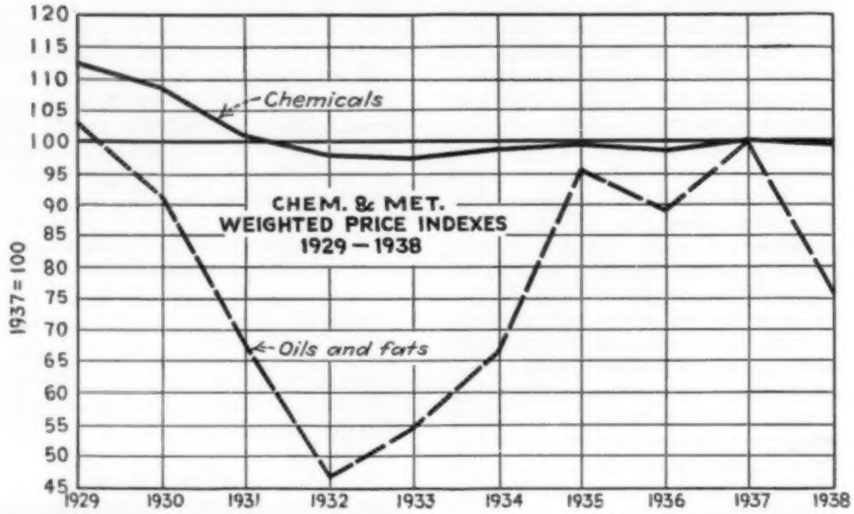
New census data make it possible to give current price weightings for chemicals, oils and fats

ALTHOUGH *Chem. & Met.'s* indexes of prices for chemicals and vegetable oils and fats were revised when census data for 1935 became available, the recent release of the statistics for 1937, has made it advisable to adopt the latest official figures as the base figures for the two indexes. Internal changes within the chemical industry bring about material changes in the relative importance of many products and in cases where there is a downward price movement due to improved technology or to other circumstances which are not bound up with a general trend, the volume ratings of the products involved become more essential in registering the price status of the industry.

In the present revision, no changes or additions have been made in the list of chemicals which were included in the index as previously compiled. These chemicals were selected because of their tonnage ratings and because the group, as a whole, represented an equitable cross-section of the entire chemical industry. The adoption of 1937 as the base year, means that chemicals—such as chlorine — which have increased sharply in recent years, will approach closer to their present standing while those for which production has been at a stand still or has been diminishing, will likewise be more accurately weighted.

In arriving at the total volume of stocks for sale, it is necessary to add imports to domestic production. However, in some cases where import figures are not included in the accompanying tabulation, it does not necessarily mean that there are no importations of that specified chemical but rather that such importations are too small in volume to be given a place in the monthly summary of the Department of Commerce and hence their inclusion or omission is not of moment in establishing the individual weightings.

Cottonseed oil holds such a preëminent



Basic Data for Chem. & Met. Weighted Index of Chemical Prices

	Production	Imports	Total supply	Basic Price	Value	Per cent of total
Acid, acetic, 28 p.c., lb.	470,159,272	31,632,680	501,791,952	$0.0243	$12,193,544	2.16
Acid, hydrochloric, 18°, lb.	870,152,600	....	870,152,600	.01	8,701,526	1.54
Acid, nitric, basis 36°, lb.	672,504,800	....	672,504,800	.05	33,625,240	5.95
Acid, sulphuric, basis 60°, ton	6,259,344	1,376	6,260,720	11.00	68,867,920	12.19
Alcohol, butyl, lb.	79,933,577	....	79,933,577	.085	6,794,354	1.20
Alcohol, denatured, gal.	98,878,000	....	98,878,000	.328	32,431,984	5.74
Aluminum sulphate, lb.	788,876,000	5,728,000	794,604,000	.0135	10,727,154	1.90
Ammonia anhydrous, lb.	223,040,588	....	223,040,588	.155	34,571,291	6.12
Ammonium sulphate, lb.	1,289,740,739	165,706,000	1,455,446,739	.0138	20,085,165	3.56
Aniline oil, lb.	38,850,344	....	38,850,344	.15	5,827,552	1.03
Arsenic, white, lb.	19,872,000	38,850,344	58,722,344	.03	1,761,670	.31
Benzol, gal.	26,795,497	....	26,795,497	.16	4,287,280	.76
Borax, ton	126,160	....	126,160	43.00	5,424,880	.96
Calcium carbide, lb.	386,090,000	....	386,090,000	.05	19,304,500	3.42
Carbon bisulphide, lb.	155,237,735	....	155,237,735	.055	8,538,075	1.51
Carbon tetrachloride, lb.	78,708,690	....	78,708,690	.055	4,328,978	.77
Chlorine, liquid, lb.	892,522,000	....	892,522,000	.0215	19,189,223	3.40
Copper sulphate, lb.	71,917,889	90,287	72,008,176	.0512	3,686,819	.65
Ethyl acetate, lb.	69,637,571	....	69,637,571	.0725	5,048,724	.90
Formaldehyde, lb.	75,000,000	....	75,000,000	.0575	4,312,500	.77
Lithopone, lb.	325,099,884	11,202,000	336,301,884	.0425	14,292,830	2.53
Phenol, lb.	65,689,782	....	65,689,782	.1325	8,703,896	1.54
Methanol, synthetic, gal.	31,814,046	....	31,814,046	.332	10,562,263	1.87
Salt cake, ton	269,177	196,586	465,763	13.00	6,054,919	1.07
Soda ash, 58% light, lb.	6,074,842,000	....	6,074,842,000	.0105	63,785,841	11.29
Soda, caustic, solid 76%, lb.	1,923,182,000	....	1,923,182,000	.023	44,233,186	7.83
Sodium bichromate, lb.	97,394,000	....	97,394,000	.066	6,642,800	1.18
Sodium phosphate, lb.	277,424,000	12,451	277,436,451	.0197	5,465,498	.97
Sodium silicate, lb.	1,282,902,000	....	1,282,902,000	.008	10,263,216	1.82
Sulphur, ton	2,466,512	398	2,466,910	18.00	44,404,380	7.86
Turpentine, gum, gal.	25,754,600	383,850	26,138,450	.394	10,298,549	1.82
White lead, dry, lb.	144,313,029	68,000	144,381,029	.0775	11,189,530	1.98
Zinc oxide, lb.	321,889,816	1,550,646	323,440,462	.0594	19,212,363	3.40
					$564,817,650	100.00

CHEM. & MET.

Weighed Index of

CHEMICAL PRICES

Base = 100 for 1937

This month	**98.27**
Last month	98.64
February, 1938	101.04
February, 1937	99.48

A lower price range was in effect for many of the solvents. Spirits of turpentine, however was advanced in price. Heavy chemicals held an unchanged position. Lead salts were firmer following a rise in the metal market.

CHEM. & MET.

Weighted Index of Prices for

OILS AND FATS

Base = 100 for 1937

This month	**67.71**
Last month	72.02
February, 1938	79.79
February, 1937	113.77

The index for vegetable oils and fats fell sharply as a result of downward revisions which ran rather generally throughout the market. Crude cottonseed led in the decline and the edible oil group followed suit. Linseed oil was an exception with a firmer tone in evidence.

position in the vegetable oil industry that the mean price level may be affected more by the extent of the cottonseed supply from year to year than by the activity of consuming industries. However, the figures of the 1937 census bring into sharp relief the growing importance of the domestic soybean crop and developments since 1937 give even more emphasis to the competitive influence of this oil. Cottonseed oil likewise is currently facing the probability of losing a larger than usual part of the edible market because of the prospective increase in the supply of lard. Hence, inter-commodity competition appears to be gaining as a price factor.

The long-continued attempts to establish a domestic tung oil industry failed to place that oil on a higher plane in the revised index based on the 1937 crop. More encouraging reports have come out of the south regarding the outturn for 1938 and the prospective yield for the present year. Despite the interference with the movement of tung oil from points in China, ample stocks have been held in domestic markets but prices at times have responded to influences originating in primary markets.

The figure given for China wood oil—tung oil—is a trade estimate as official figures were not issued. Production data, as set forth for the two indexes, are on the authority of the Bureau of the Census, the Tariff Commission report on dyes and other synthetic organic chemicals and, in the case of formaldehyde, on trade estimates.

Basic Data for Chem. & Met. Weighted Index of Oils and Fats Prices

	Production lb.	Imports lb.	Total supply lb.	Base price 1937 — per lb.	Total value	Percent of total
Cottonseed oil	1,363,978,069	194,008,241	1,557,986,310	$0.08	$124,638,905	29.94
Linseed oil	665,098,850	392,729	665,491,579	.107	71,207,599	17.11
Coconut oil	266,419,787	337,375,696	603,795,483	.064	38,642,911	9.28
Corn oil	126,095,341	32,925,544	159,020,885	.0855	13,596,286	3.27
China wood oil	500,000	174,884,803	175,384,803	.1573	27,582,514	6.63
Castor oil	68,823,645	800,406	69,624,051	.1025	7,136,465	1.71
Soybean oil	194,132,315	29,752,024	223,884,339	.078	17,462,978	4.20
Peanut oil	50,724,281	57,999,446	108,723,727	.086	9,350,241	2.25
Palm oil	....	411,112,412	411,112,412	.056	23,022,295	5.53
Menhaden oil	3,891,142	....	3,891,142	.389	1,513,654	0.36
Tallow, inedible	430,010,221	3,850,831	433,861,052	.0806	34,734,971	8.35
Red oil	47,765,749	230,570	48,096,319	.105	5,050,113	1.21
Oleo oil	74,987,083	2,242	74,989,325	.1275	9,561,139	2.30
Olive foots (sulphur oil)	....	22,100,922	22,100,922	.11	2,431,101	0.58
Glycerine, crude	167,882,458	13,598,403	181,480,861	.167	30,307,304	7.28
					$416,238,476	100.00

Chem. & Met. Weighted Index Numbers for Chemical Prices

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
January	111.99	112.33	103.04	99.28	97.28	99.18	99.70	99.38	99.54	100.84
February	112.16	111.72	102.49	98.98	97.08	99.50	99.64	99.20	99.48	101.04
March	112.49	111.50	103.15	98.50	97.23	100.01	99.67	99.23	99.68	100.43
April	112.30	110.41	100.42	97.74	96.99	100.07	99.80	98.89	100.17	100.22
May	112.40	110.27	100.60	98.34	97.15	99.89	99.89	98.49	99.97	100.24
June	112.27	109.38	100.42	97.58	97.59	99.82	99.77	98.36	99.88	99.88
July	112.21	108.07	99.69	97.29	98.22	99.37	99.66	98.46	100.14	99.91
August	112.29	106.39	99.54	97.48	98.67	99.24	99.83	98.58	100.35	99.54
September	112.26	106.63	99.60	97.39	98.55	99.14	99.65	98.54	100.51	99.55
October	112.33	106.39	99.72	97.45	98.52	99.29	99.30	98.78	100.38	98.74
November	112.54	105.88	99.00	97.43	98.77	99.54	99.29	98.75	100.09	98.90
December	112.64	104.19	98.89	97.45	99.13	99.78	99.44	99.01	99.81	98.92
Yearly average	112.32	108.60	100.55	97.91	97.10	98.74	99.64	98.81	100.00	99.86

Chem. & Met. Weighted Index Numbers for Oils and Fats

1937 = 100

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
January	106.27	103.11	78.15	50.03	43.63	54.91	88.93	91.35	114.31	78.05
February	105.27	102.18	76.62	50.07	42.89	57.45	93.69	90.74	113.77	79.79
March	103.98	95.79	75.02	49.65	44.08	59.85	102.72	85.33	114.72	80.31
April	104.53	96.30	76.54	44.77	43.77	60.72	98.94	87.41	117.85	77.28
May	99.59	95.92	72.66	43.78	54.13	60.61	98.00	82.87	106.48	76.79
June	96.65	93.66	69.76	41.69	58.53	61.36	95.89	81.30	100.28	72.34
July	97.33	91.13	72.02	44.18	64.64	64.12	91.28	88.05	94.39	76.11
August	100.65	89.53	67.01	45.29	68.44	66.05	88.84	91.84	92.47	79.37
September	105.40	83.32	55.36	50.98	60.89	71.27	92.78	91.55	89.42	73.54
October	108.43	78.94	53.77	48.38	57.26	76.14	100.17	92.86	89.83	73.50
November	102.09	80.59	55.30	45.89	56.80	76.39	97.98	91.61	85.84	71.89
December	102.70	79.32	53.51	43.11	55.32	84.21	96.79	97.86	80.64	72.21
Average	102.74	90.82	67.14	46.50	54.20	66.09	95.60	89.40	100.00	75.93

RAYON AND FIBERS

(*Continued from page* 119)

presumably to compete with nylon. Trade opinion expects the fiber to be a super-stretched acetate of extremely high strength. Carbide & Carbon Chemicals Corp. is still experimenting with its Vinyon yarn produced from a vinyl compound. American Viscose Corp. has a semi-works plant operating at Marcus Hook on still another type of yarn, the character of which has not been announced.

Not only was there much activity in the development of new fibers, but one of the oldest, viscose, received an impetus during the year which may have far-reaching effects. At present, the rest of the industry is attentively watching the results of the new continuous spinning process installed by the Industrial Rayon Corp. at its new Painesville, Ohio, plant. The new plant, which has been described in detail in *Chem. & Met.* (Dec. 1938, p. 668), employs a fully continuous process from the spinneret through the production of dry, twisted yarns. Thus, the plant has a normal chemical end, for the production of viscose, and normal winding, inspection and shipping departments. But for the rest it eliminates a tremendous number of batch operations and greatly simplifies the problem of producing a uniform product.

Fibrous glass, the inorganic textile fiber which first broke into the headlines as a commercial material about a year ago, after a development period dating only since 1935, has been busy exploring its markets during 1938, and has made a definite place for itself in electrical insulation, principally, as well as in filtration. Perhaps the most important development of the year was the consolidation of the interests in glass fiber of both Owens-Illinois Glass Co. and Corning Glass Works in a new concern, Owens-Corning Fiberglas Corp.

A certain amount of interest in the possibilities of soybean protein for the spinning of fibers has been reported, while the U. S. Department of Agriculture has worked on the use of casein for the purpose, and has applied for public patents on a process which is said to have been investigated by a number of interested manufacturers. Production of Lanital casein fiber in Italy has continued and the process has been offered for license in the United States, but has not been taken over by any manufacturers. Lanital production in Italy was expected to amount to 10,000,000 lb. in 1938, according to the Department of Agriculture report previously mentioned, a production which required considerable casein imports.

The Department of Agriculture report draws some interesting conclusions from its study of synthetic fibers. It infers that expansion for the rayon industry is by no means at an end, but that the production of continuous filament rayon has entered a definitely less expansive period. It points to the fact that the uses for continuous filament rayon are limited and suggests that many of them have already been fully exploited. Its conclusion in regard to the use of rayon in tire fabrics is at variance with some of the more optimistic predictions, stating that in ordinary classes of service, such as light trucks and passenger cars, superiority for the rayon-reinforced tire seems to be lacking in comparison with cotton, although it is definitely superior for extra-heavy duty at high speeds over long distances. The report estimates a potential displacement of cotton of from 50,000 to 100,000 bales in this service, as compared with a total consumption of 600,000 bales of cotton in the manufacture of tire fabric in 1936.

Just what performance was turned in, in 1938, by cellulose and cellulose acetate transparent sheeting is impossible to say, for no figures on production are ever released. Assuming that the growth trend was temporarily stopped, but not reversed, it is likely that in the neighborhood of 70,000,000 lb. of cellulose and 10,000,000 lb. of acetate was produced. Continuous price reductions in these materials have taken place. Cellophane, for instance, was introduced in 1924 at $2.65 per pound. In 1938 the uncoated grade was reduced for the 19th time, to $0.34 per pound. The moisture proof material, introduced at $1.60 in 1927, reached $0.41 in 1938.

ORGANIC CHEMICALS

(*Continued from page* 123)

From the foregoing remarks concerning the restricted requirements for all acetic derivatives and the increased productive capacity for acid, it is easy to explain the price declines for acetic acid, and ethyl and butyl acetate. Another factor which undoubtedly affected prices was the cut in tariff. Trade opinion asserts that it is not at all unlikely that 1939 may bring further price reductions.

Dyes and Medicinals

Production of dyes declined about 17 per cent in 1938 from the 1937 production of 122 million pounds, according to trade estimates. This reflects a drop in the textile industry, largest consumer of dye products. Technical improvements manifested themselves in continued growth of the azo classes of dyes and certain of the "unclassified" dyes as reported in the Dye Census of the United States Tariff Commission. Medicinals declined but little. The industry is a fairly stable one because of the necessary character of its products. Sulphanilamide continues to be in the limelight as a medicinal holding much promise for future expansion.

CENSUS DATA

(*Continued from page* 129)

CANE SUGAR REFINING

	1937	1935
*Production, total value	$424,630,784	$377,214,442
Refined sugar, hard		
Tons	4,251,286	3,914,804
Value	$395,142,101	$349,280,365
Refined sugar, soft or brown		
Tons	204,296	295,162
Value	$22,603,146	$23,409,448
Refiners' sirup, edible		
Gallons	2,735,498	2,886,558
Value	$546,826	$599,117
Refiners' blackstrap and non-edible sirup, gallons	23,380,364	22,305,646
Value	$1,399,024	$1,320,870
Other sugar products		
Value	$2,618,646	$1,739,213
Raw Sugar Treated		
Aggregate tons	4,722,660	4,398,345
Domestic, total	1,947,851	1,781,404
United States exclusive of outlying possessions	324,368	145,383
Hawaii	890,460	956,378
Puerto Rico and Virgin Islands	733,023	679,643
Foreign, total	2,774,809	2,616,941
Cuba	1,735,421	1,762,950
Philippines	924,302	811,440
All other	115,086	42,551

* No data for products of cane-sugar mills are included.

TANNING MATERIALS, ETC.

Aggregate value	$39,004,416	$30,453,206
Made as secondary products in other industries (included above)	$7,193,505	$3,922,936
Tanning materials, value	$9,858,041	$9,919,193
Natural dyestuffs, value	$1,407,500	$941,524
Mordants, value	$575,361	$537,947
Tannic acid (basis 100%),		
Pounds	1,015,914	724,552
Value	$381,847	$304,728
Assistants, value	$16,753,052	$11,440,495
Sizes, value	$10,410,462	$7,614,047

WOOD DISTILLATION

Total value	$26,406,368	$15,757,931
Methanol (wood alcohol)		
Crude, gallons [1]	1,814,670	1,948,606
Value	$287,026	$315,753
Consumed where made,		
Gallons [1]	4,193,423	3,100,114
Refined, gallons [2]	3,437,758	3,648,180
Value	$1,030,534	$1,148,548
Acetate of lime (gray)		
Tons [3]	22,508	25,851
Value	$720,739	$825,522
Miscellaneous chemicals (Acetic acid, ethyl acetate, methyl acetate, etc.)[4]		
Value	$2,170,879	$1,969,068
Tar, gallons	8,137,913	3,370,781
Value	$894,461	$598,560
Consumed where made		
Gallons	4,073,363	6,443,153
Tar oils, gallons	1,018,609	1,087,492
Value	$209,448	$194,261
Turpentine, wood		
Gallons	[5] 8,723,503	4,611,641
Value	[5] $2,249,716	$1,853,925
Pine oil, gallons	4,536,084	3,443,315
Value	$2,395,364	$1,525,938
Resin, wood		
Barrels (500 lbs.)	[6] 790,629	529,001
Value	[6] $10,400,478	$4,171,862
Charcoal		
Bushels [7]	27,461,211	25,760,069
Value [7]	$3,824,145	$3,051,804
Other wood products		
Value	$2,223,578	$102,690

[1] Basis, 82 per cent. [2] Basis, 100 per cent. [3] Basis, 80 per cent. [4] The production of acetic acid in the Chemical industry is shown above under "Chemicals." [5] Includes production of 2,396,043 gallons, valued at $259,992, by the wood sulphate process. [6] Data includes production by wood sulphate process of 1,473 tons, valued at $127,129. [7] Includes data for charcoal screenings; production for sale for 1937 amounted to 389,507 bushels, valued at $31,462; for 1935, 182,000 bushels, valued at $10,074.